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Editorial Notes

The National Fuel Problem

THE Institute of Fuel has in its comparatively short existence done a great deal to bring light to bear on the broad aspect of that highly important problem of how best to utilize the nation's fuel resources to the best advantage. The problem was discussed anew at a joint meeting of the North-Western Section and the Manchester District Association of Gas Engineers, when a Paper was presented by Mr. P. Chantler, of the Economics Research Section at Manchester University. Our report of the meeting and of the speeches at a luncheon which preceded it was published in the "JOURNAL" last week, and on both occasions several interesting points were brought out and several interesting opinions expressed.

In his Paper Mr. Chantler—whose recent book "The British Gas Industry" was reviewed in the "JOURNAL" for June 1 last—spoke of the "dis-economics" of burning raw coal, thereby forming clouds of "aerial sewage" and later a carpet of dirt on surrounding lands and buildings. The social costs of the smoke menace, he very rightly emphasized, are enormous; they should be intolerable in a properly organized society. The Author pointed to the steady progress of the Gas Industry in sales—an increase of 12% from 1926 to 1936—but also to the steady decline in consumption per consumer, which he attributed to the use of more efficient appliances and also to the inroads of electricity which have not been offset by the development of new gas loads. The two loads which cry out for development are, of course, the water heating load and the space heating load—the latter, the biggest potential load for gas, has hardly been touched. Nor will it be gained without the adoption of attractive tariffs; and, as the Author maintained, and as we have stressed repeatedly in these columns, a rate structure which gives lower rates for increased gas consumption, but which does not reduce the rate low enough to compete with raw coal, will not effect the desired result. Competitive prices for increased consumption, for the replacement of raw coal by gas, are needed. To our mind, such rates will be possible only by maintaining a good coke market. The space heating field for gas will be developed by an economically balanced gas and coke supply. If far more attention is given than at present to the coke market and gas is, as a result, able to be offered at competitive rates, then there will be no such thing as a decline in the consumption per consumer figure.

The putting into operation of attractive tariffs for gas demands a knowledge of economics and an understanding of market trends; and it is too much to expect the smaller undertakings to have such specialist knowledge. For which reason Dr. E. W. Smith, in the course of discussion on the Paper, reiterated his advocacy of the establishment within the Industry of a bureau of economics—of some authority which could undertake the responsibility of advising the smaller undertakings, and regard the whole problem from the national point of view. The idea of a bureau of economics was broached, it may be recalled, by Dr. Smith in 1937, when he suggested that its purpose should be to study every phase of the Industry from the economic point of view, to collaborate with Government departments in carrying out surveys of domestic and industrial requirements for heat and light, to study the real trend in connexion with the coke-gas ratio, the relationship between costs of production and selling prices, and the effect of changes in the tastes and habits of the consumer.

Watch Coke Sales

As things stand there is too wide a divergence of individual policy, too little co-ordination, too little regional planning. There is need for more co-ordinated effort, a greater unity of policy and purpose, in the sale of both gas and coke. In some areas much has been done in the furtherance of coke sales. Insistence has been had on the uniformity of coke deliveries, and coke-burning grates, gas ignited, have been popularized. But how little general endeavour has been made to press home on the housewife and the householder the very great advantages of the coke grate and its unassailable economy With the growing public demand for smokelessness and labour saving, with the millions of tons of raw coal being used for room heating and water heating, the paucity of general effort in the sale of coke is more than difficult to understand. The present domestic sales of gas coke are nothing to what they could be; and the extension of

gas for both these purposes would go hand in hand with greater coke sales. If the public was properly educated to its use, there should be no difficulty whatever in getting rid of all the solid fuel made within a Gas Industry of far larger dimensions than those we know to-day. "Coke," said Sir David Milne-Watson recently, "is an essential element in our programme for cleaner cities; it is also in a financial sense one of the two legs with which the Gas Industry marches." Let us see that the coke leg does its full duty in the matter of propulsion towards the smokeless goal and a more important, more dominant Industry. The domestic heating problem can be solved, the air of our towns and cities cleansed, and labour saved, by the use of gas and coke—and at no greater cost to the individual. The immense saving to the community needs no stressing.

There were two other matters touched upon at the meeting in question to which we would refer. The first relates to the status of the Institute of Fuel, which in its short history has stimulated such a widespread interest in fuel problems. The Council is now considering the question of obtaining a Charter, and it is believed that there will be no difficulty in getting one, for the Institute does not cut across the interests of any other professional organization. The suggestion is to form a new class of membership which will involve a qualification, maybe the necessity of sitting for an examination. The other matter was that of setting up a professorship of fuel at Manchester; and the meeting was informed that at the present time there is a strong movement for the installation of such a Chair at the Manchester College of Technology. Certainly the subject is big enough and broad enough to deserve such a distinction.

Gaseous Combustion

THE work of many investigators has served to show that the apparently simple process of "lighting the gas" may set in motion trains of highly complex physico-chemical processes. A select band of workers has been engaged in unravelling the difficult subject of the mechanism of combustion, and pre-eminent among these have been the Sheffield School (including the Safety in Mines organization) under Professor Wheeler, the South Kensington School under the late Professor Bone (in which must now be included Professor Egerton, who has become Professor Bone's successor at South Kensington), and some overseas scientists such as Neumann and Prettre. The list is not complete, but it may suffice to explain that the views of these several schools of thought are not identical and sometimes lead to controversy.

Professor Townend, who is a primary product of the reactions at South Kensington, having now retraced the trail of his former chief by proceeding from that seat of learning to Leeds, has succeeded in making the heads of unfortunate gas engineers ache by indicating how complicated are the processes that they initiate and are supposed to control. Professor Townend, unlike Professor Cobb, has, we believe, no practical experience of industry, but has been wholly engaged in the academic field. It is evident that his prime interest lies in the field of combustion, and it may be expected that the Transactions of The Institution of Gas Engineers will be enriched in that direction as the result of his contact with the work of the Gas Industry. He would only ask him always to remember—as academic investigators all too frequently fail to do—that few of those engaged in industry have the time to follow the ramifications of complicated experimental work or to weigh the niceties of rival theories. They will appreciate more than anything a simple exposition of facts, which must be put before them in easily assimilable form if full practical value is to be derived from the labours of the investigator.

Two Papers were published by Professor Townend during the month of November which demand study by those who are interested in the subject of flames—and what gas engineer is not? These are the Inaugural Address which he gave at Leeds University, and a Paper on "Some Combustion Phenomena of Higher Hydrocarbons" read before the Institute of Fuel. These Papers show clearly how complex is the process of combustion; that, in fact, it is even more complex than we had suspected. The course of the process is dependent upon the concentration of the reactants, upon the nature of the combustible, upon the presence or rate of formation of certain secondary products, upon the pressure, and upon the temperature; and as several of these factors may be operating simultaneously, it is not altogether surprising that even Professor Townend is frequently constrained to pull himself up short with the confession that he has reached the limits of present-day knowledge.

A New Era

EVEN for so seemingly simple a reaction as the combustion of hydrogen or of carbon monoxide there are three theories (at least). These are generally referred to as the hydroxyllation theory, the peroxide theory, and the chain reaction theory. We will not presume to discuss these theories here, for to do so would be akin in temerity to interfering in the historic struggle between the Kilkenny Cats. It appears to us that Professor Townend leans towards the chain reaction theory in which it is suggested that the first stages of combustion involve the formation of unstable intermediate products similar in constitution to unattached hydrocarbon chains (*e.g.*, $:CH_2$ or $\cdot OH$) which carry considerable amounts of energy and which then take part in further reactions, being renewed as further energy is developed. We may have to distinguish between the reactions that occur during combustion proper and the reactions that lead up to combustion. Professor Townend in his Leeds lecture stated his belief that our knowledge of the slow combustion processes leading up to spontaneous ignition is now developing so rapidly that we may well be said to be entering upon a new era in combustion. These are high hopes, but whether they mean that we are now entering upon a new era in our scientific knowledge of combustion or upon a new practical technique of combustion does not yet appear. It is of the utmost importance that investigators should develop the technique of explaining to practical men the practical significance of their researches.

Most of our knowledge of combustion has been obtained from the observation of explosions in suitable laboratory apparatus. Such knowledge is, of course, equally applicable to flames as the gas engineer knows them because the two processes are identical. In explosions the flame travels through the gaseous mixture, whereas in stationary flames the explosive mixture travels so that the flame appears stationary.

All theories of the mechanism of combustion depend upon the conception that what appears to be a simple reaction such as $2H_2 + O_2 = 2H_2O$ is, in reality, a complex series of, perhaps, half-a-dozen chemical reactions, that just written representing only the initial mixture and the final product. The researches that are being conducted by Professor Townend and others are attempts to elucidate the nature of the intermediate reactions and the kinetic and thermodynamic laws which govern them. Prominent among the conceptions

arising from the research work is that certain intermediate compounds, in particular aldehydes, act as accelerators of the reaction. It is, moreover, evident that in any chain of reactions such as appears now to be involved in combustion the ultimate rate of combustion as a whole will be governed by the rate of the slowest reaction. Whether it is that the formation of the aldehyde is the slowest reaction, or that the presence of the aldehyde "catalyzes" the whole chain of reactions, appears not to be definitely settled.

The Chain Theory

THE chain theory of chemical reactions in general has been developed by Dr. Hinshelwood at Oxford and has led to the recognition that the progress of an exothermic chemical reaction depends upon specific encounters between certain reactive species; the number of encounters at the start of any reaction must be small, and any influence either increasing or decreasing them will have an apparently disproportionate influence on the time necessary for its completion. It is on this basis that Professor Townend discusses combustion, since he looks for conditions that stimulate the production of certain intermediate compounds (not in themselves unattached unsaturated "chain" bodies) that are found to be apparently necessary for the occurrence of combustion. It is useful to follow this conception in its teaching upon the effect of pressure on combustion. Suppose that at a given constant (high) temperature a combustible mixture exists at very low pressure. Owing to the relative scarcity of the molecules collisions are not sufficiently frequent to produce the chain compounds necessary for the initiation of combustion. As the pressure increases to, say, 100 mm. mercury pressure (P_1) the rate of propagation of reaction chains becomes greater than that at which these chains are broken down through contact with the walls of the reaction vessel or other surfaces, so that spontaneous ignition begins. It appears, however, that the rate of combination is at first too small for combustion to occur as ordinarily understood, and what would here be observed would be a long induction period, during which an intermediate substance necessary for the development of rapid combustion is being built up. This induction period, even at higher temperatures, may last for hours, or as the temperature becomes yet higher may last only for fractions of a second. From the pressure P_1 up to a still higher pressure P_2 the induction period will give rise sooner or later to spontaneous ignition. Above the pressure P_2, however, the increasing concentration of the molecules permits of triple collisions which result in the destruction of the chain compounds, and spontaneous combustion becomes impossible until some higher pressure P_3 is reached, when presumably (though on this point the evidence does not appear quite clear) stable intermediates are forming that lead after a shorter induction period to ordinary spontaneous ignition. In his Leeds Address, Professor Townend stated that the spontaneous ignition of an explosive mixture is now known to depend largely upon the *partial* pressures or absolute concentrations of the reactants involved. His mention of partial pressures, which we have italicized, suggests that in the phenomena we have just described the presence of an inert diluent gas such as nitrogen would serve the same purpose as a vacuum in reducing the pressure of the reactants. The experiments thus have an immediate practical bearing. This was shown by Dr. White at Ardeer, who found that ether-air mixtures containing from 2 to 9% of ether and from 19 to 45% of ether were inflammable, but that the other ranges of ether concentration were incapable of flame propagation. The concentration of 2 to 9% gave rise to normal flames and the higher concentration to the so-called "cool flames" to be described later.

"Cool Flames"

HAVING thus attempted to describe in simple language the effect of pressure on flame propagation at constant temperature we turn to the effect of temperature at constant pressure. In his Institute of Fuel lecture, Professor Townend illustrated this by the work of Pope, Dykstra, and Edgar on higher paraffins. Initial oxidation begins between 150° and 200° C. and by 250° to 270° C. it becomes so active that the products are luminescent. During the next temperature range, 270° to 300° C. oxidation is so rapid that the mixture becomes mildly explosive and we have what Professor Townend calls a "cool flame." This is a zone of incomplete combustion which travels very slowly. It is now known that the cool flame processes at atmospheric pressure are those most associated with the phenomena of "knock" in engines. At temperatures above 300° C. it was found that the combustion velocity again diminished so that cool flame ignition ceased, while above 500° C. normal rapid combustion occurred.

The focus of investigational interest appears now to be the cool flames. Methane, ethane, and other hydrocarbons containing less than 3 carbon atoms do not appear to form cool flames. It is now known that among the intermediate compounds formed during oxidation that serve to accelerate combustion are the aldehydes; these, and certain other known intermediates of oxidation processes have been identified among the products of reaction and are known to be powerful accelerators of combustion. There seems to be ground for the conclusion of Newitt and Thornes that a necessary condition for the development of cool flame inflammation is the attainment in the medium of a critical high concentration of higher aldehydes. There is a less intense development of cool flames in the olefines than in the paraffins, probably because there is a slower building-up of active centres depending on aldehyde concentration because of the difference in the chemical stages involved. Formaldehyde, benzene, ethyl alcohol, and methyl alcohol do not form cool flames, but acetaldehyde does, and is the simplest material yet known to do so. Ethers give two cool flame systems, one a lower system about 200° C. due probably to the primary oxidation of ether and the second at 300° to 350° C. which is similar to that observed with the paraffins.

The importance of the cool flames in practice appears to be that they are the initiators of normal combustion. The velocity of a normal flame depends upon the available heat in the medium; that of the cool flame does not, being propagated most easily through those mixtures which are most active during slow combustion and travelling at constant speed; at pressures somewhat higher, the cool flames give place to normal flames. It happens that with simple molecules, which do not appear to give rise to cool flames, the particular combustible-oxygen ratios most likely to produce cool flames lie within the range for ordinary flames; Professor Townend hopes that this fact may enable investigations on cool flames in more complex molecules to assist in the elucidation of the mechanism of flame propagation in simple hydrocarbons.

It cannot be said that these investigations appear to be of direct and immediate applicability to the problems of the Gas Industry. The problems of the aeration test burner are not affected directly by this work, partly because it can hardly be

anticipated that cool flames would play any part in the operation of a normal gas flame. Nevertheless, it is yet early to say how far our ideas on the design of gas appliances may be modified in the future by the knowledge of the exact fundamental processes of combustion. This work is an excellent example of that "long-range" research work which it must be the care of the Gas Industry to foster, not because of its immediate applicability but because of its possible future consequences. May we look forward in the future to hearing Professor Townend's views upon the practical significance to the Gas Industry of the work that is being done on the fundamental processes of combustion?

Quality Control

On the question of standardization and quality control Mr. S. F. Dunkley, of the Gas Light and Coke Company, has wide knowledge and long experience, and the Paper which he gave to the Southern Association of Gas Engineers and Managers, publication of which we complete in our issue to-day, will be studied with great profit. He pointed out the need for and advantage of co-operation testing and quality control and described in detail a system evolved by his Company based on liaison between the technician and the buying public. He expressed regret that, though many national standard specifications have come into being, in many industries, including the Gas Industry, there is still a tendency towards duplication. It would facilitate production methods and effect a reduction in manufacturing costs if such duplicated specifications were combined into national specifications. These would represent the general consensus of opinion among manufacturers and technicians throughout the country. The economies which could be effected in manufacture, storing, and maintenance all seem to point to this as an ideal system.

In the light of experience Mr. Dunkley said that the expense involved in testing is more than balanced by the saving effected due to reduction in complaints, longer life of the goods, and the ability of the buyer to purchase safely at competitive prices. In addition, there is the reputation of the Industry to consider. Testing, he urged, should be carried out over as wide an area as possible, in which respect there is scope for further development in the Gas Industry. If more widespread control was carried out by the smaller gas undertakings and manufacturers the Industry would benefit. A very important point made by Mr. Dunkley was that the testing inspector should always have before him the aim of assisting the maker as much as possible by constructive criticism. A careful check, he said, should be kept on each item, from the laboratory stage through the manufacturing stage to the final stage when the item is in use; the views of the research worker, the maker, the salesman, and finally the user should all be considered and should play a part in deciding improvements and the severity with which any item need be tested.

With full co-operation between seller, buyer, and user benefit will ultimately accrue to all concerned. As far as our Industry is concerned it means better all-round service to the consumer; and the consumer's gain will also be the manufacturer's gain.

Personal

Mr. H. G. Broadbridge, of the Leamington Priors Gas Company, has been appointed Engineer and General Manager of the Andover Lighting and Power Company.

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Members of the Birkenhead Branch of the National Association of Local Government Officers have elected Mr. J. Hood, A.M.I.Mech.E., F.I.A.C., Engineer and Manager of the Birkenhead Gas Department, to the position of President.

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After seventeen years in the employ of the Derby Gas Light and Coke Company, Mr. J. W. Chambers, B.Sc., Junior Technical Assistant, is leaving to become Industrial Gas Engineer to Rossendale Union Gas Company. To mark the occasion he was presented on Nov. 29 with a cheque by Mr. J. P. McCrae, Chief Engineer of the Derby Company.

Obituary

John E. Cowen.

Tyneside lost one of its most prominent industrialists by the death of Mr. John Edward Cowen, on Dec. 2, at Minsteracres, near Slaley. Mr. Cowen, who was 65, had been ill for a considerable time.

His business interests were many and varied. Chairman of the Newcastle and Gateshead Gas Company, he also presided over the Boards of the Stanley and District Gas Company, Smith, Patterson, & Co., Ltd., the Blaydon Ironfounders and Engineers; Taylor, Stoker Company, Ltd., Engineers, London; the Redheugh Bridge Company (recently liquidated in view of the sale of the bridge to Newcastle and Gateshead Corporation), and, until a year ago, the High Gosforth Park Company (promoters of Newcastle's race meetings). The last-named Chairmanship, in which he has been succeeded by Mr. Fred Straker, Mr. Cowen resigned owing to the state of his health. In addition to the above chairmanships Mr. Cowen was a Director of the Consett Iron Company, Ltd.; the Consett Spanish Ore Company, Ltd.; Walter Scott, Ltd., Durham colliery owners and Leeds steel manufacturers; Swift, Rutherford, & Co., Ltd.; and the Tyneside Investment Trust, Ltd. He was Chairman, besides, of the Newcastle district board of the Phœnix Assurance Company, Ltd.

Eldest and only surviving son of Colonel John Cowen, of Blaydon Burn, he was a grandson of Sir Joseph Cowen, of Stella Hall, Blaydon, who was the first Chairman of the Tyne Commissioners and M.P. for Newcastle for some years. The famous Mr. Joseph Cowen, Newcastle newspaper-owner, politician, and social reformer, was his uncle.

Early in life Mr. Cowen became interested in the collieries and fireclay businesses founded by his family, and he travelled extensively on the Continent, developing the sale of retorts and firebricks to gas-works and other users. Later he became more particularly interested in the Blaydon Iron Foundry of Smith, Patterson, & Co., of which his father was one of the founders and first Chairman. Eventually Mr. Cowen became Managing Director and Chairman. He joined the Newcastle and Gateshead Gas directorate in 1906 and became Chairman in 1918. Under his leadership the Company considerably developed its interests, taking over the Walker and Wallsend, Tynemouth, Chester-le-Street, and other undertakings, and culminating at the beginning of this year with the acquisition of the South Shields Company. Mr. Cowen's prominence in this particular field was acknowledged by his election to the Presidency of the British Commercial Gas Association in 1926. The Association went to Newcastle for its Conference that year. Mr. Cowen was a Justice of the Peace for both the counties of Durham and Northumberland, presiding over the Gateshead County Bench and serving as Northumberland's High Sheriff in 1927. He was also a member of the Durham Standing Joint Committee and, for ten years until 1936, of the Northumberland Agricultural Wages Board. He was educated at Clifton and abroad. In 1903 he married Mabel Hunter, younger daughter of the late Mr. George Thompson, of Winlaton. Mrs. Cowen survives with their three sons and a daughter. The eldest son, Mr. John David Cowen, is one of the local Directors of Barclays Bank and is on the Newcastle and Gateshead Gas Company's Board.

The interment at Healey was private, but there was a public memorial service in Newcastle Cathedral on Monday.

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W. L. Galbraith.

The death occurred on Dec. 4, at the age of 69, of Mr. William Lyle Galbraith, M.A., who retired from the Secretaryship of the Gas Light and Coke Company early last year. Mr. Galbraith came of a Scottish family and was the son of a civil engineer who was a member of the firm of Galbraith & Church. He was educated at Winchester College and Merton College, Oxford, and afterwards read for the Bar, being "called" in 1896. After practising for some years as an equity draftsman and conveyancer

at Lincoln's Inn, Mr. Galbraith entered the service of the Board of Education and was originally employed in their legal department and later in connexion with technical education in London and the South. He was appointed Secretary of the Gas Light and Coke Company in succession to the late Mr. W. Beckford Long in January, 1918.

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Mr. CHARLES MURLESS, Chairman of the Wrexham Gas Company, died on Nov. 27, following a road accident. Mr. Murless, who was eighty-five years of age, was twice Mayor of Wrexham. He was knocked down in a Wrexham street by a motor van on the previous Friday evening.

Letters to the Editor

The Porthcawl Appointment

SIR,—My attention has been drawn to the letter from Mr. Shapley, of Leeds, published in the current issue of the "JOURNAL" in regard to the Porthcawl appointment and what he describes as the meagre salary offered.

I should not like your readers to think that the Wales and Monmouthshire Association of Gas Engineers and Managers, in whose area the Porthcawl Undertaking is situated, is disinterested in the matter.

A meeting of the Council was immediately called after the appearance of the advertisement, and a letter subsequently addressed to the Chairman of the Porthcawl Urban District Council asking for a reconsideration of the amount of salary offered, particularly in view of the stipulation that applicants should be members of the Chartered Institution of Gas Engineers.

Yours, &c.,
OCTAVIUS THOMAS,
Hon. Secretary.

Wales and Monmouthshire Association of Gas Engineers and Managers,
Dec. 1, 1938.

Institution of Chemical Engineers' Examinations

SIR,—I was interested to read in the current issue of the "JOURNAL" the reference, on p. 691, to the Associate-Membership Examination of this Institution. I think I should point out that the time allowed for the completion of the "Home Paper" is approximately ten weeks, and not three weeks, as stated. It would be quite impossible for candidates to submit adequate answers in the time mentioned in the "JOURNAL," and no doubt this is due to a misunderstanding.

Yours, &c.,
M. B. DONALD,
Joint Hon. Secretary.

Institution of Chemical Engineers,
56, Victoria Street, S.W. 1,
Dec. 1, 1938.

Amalgamation and Grouping

Coatbridge and Airdrie.

The Airdrie Town Council have asked the Coatbridge Gas Company to make a final offer for the purchase of the Airdrie Municipal Undertaking, to which reference has been made in earlier issues of the "JOURNAL." Representatives of the Council have interviewed the Directors and officials of the Coatbridge Company, the latter being now asked to put their offer in writing.

Darlington and Gainford.

Among the objects of a Special Order, under the Gas Undertakings Acts, 1920 to 1934, for which the Darlington Corporation intend applying to the Board of Trade is the acquisition by agreement of the Gainford Undertaking. [In the notice in the Dec. 2 issue of the *London Gazette* the expression "the Gainford Undertaking" means and includes all lands, buildings, plant, appliances, &c., belonging to and used by Mr. Robert Holmes Eddleston for the supply of gas in the parish of Gainford in the rural district of Barnard Castle.] The Order also empowers the Corporation to extend their area of supply.

Forthcoming Engagements

December

8.—G.C.P.A.—Annual General Meeting, Caxton Hall, Westminster, S.W. 1, 3 p.m., followed by Meeting of Committee.
10.—Scottish Juniors.—Joint Meeting at Glasgow. Address by Sir Frederick West and Visit to Provan Chemical Works.
10.—Yorkshire Juniors.—Visit to H. C. Slingsby, Ltd., Keighley.
12.—I.G.E.—Finance Committee, 1.45 p.m.; Membership Committee, 2.15 p.m.; General Purposes Committee, 3 p.m.
13.—I.G.E.—Council, 10 p.m.; Gas Education Executive Committee, 2.30 p.m.
13.—London and Southern Juniors.—Paper by G. Dougill, "A Serious Case of Corrosion and Its Cure."
13.—N.G.C.—Central Executive Board, 2.30 p.m.
15.—I.G.E.—Refractory Materials Joint Committee, 2.30 p.m.
15.—S.B.G.I.—Council Meeting, 2.30 p.m.
16.—I.G.E.—Liquor Effluents and Ammonia Committee, 11.15 a.m.; Joint Research Committee, 2.30 p.m.
16.—Southern Association (Western District).—Commercial Meeting, Rougemont Hotel, Exeter, 2.30 p.m.
21.—B.G.F.—Council, Gas Industry House, 12 noon.
21.—I.G.E. and S.B.G.I.—Ad Hoc Joint Committee at Gas Industry House, 2.30 p.m.

1939.

January

7.—London and Southern Juniors.—Visit to Wandsworth Gas-Works.
7.—Scottish Eastern Juniors.—Short Paper Meeting at Dunfermline.
12.—Midland Juniors.—Lecture by A. T. Green, F.I.C., of the British Refractory Research Association.
14.—Scottish Western Juniors.—Visit to Maxol Heaters, Ltd., Manchester.
14.—Southern Association (Eastern District).—At Gas Industry House, 2.30 p.m. Discussion on "Hire-Purchase with Special Reference to Hire-Purchase Act, 1938, and Commission to Employees."
14.—Yorkshire Juniors.—Paper by H. A. Fells, of Sheffield.
17.—London and Southern Juniors.—Meeting at Kennington. Paper by G. S. J. Knott on "Meters and Standards."
19.—L.C.C.A.—At Gas Industry House. Finance Committee, 10.45 a.m.; Executive Committee, 11.15 a.m.; Central Committee, 2.30 p.m.
21.—Wales and Monmouthshire Juniors.—Meeting at Newport.
21.—Western Juniors.—Visit to Cheltenham. Paper by Leopold Friedman, of Ascot Gas Water Heaters, Ltd.

"GAS JOURNAL" Directory

In order that readers may be able to keep the particulars contained in the "JOURNAL" Directory up to date, we summarize in the following list various changes which have occurred during the past month:

Page 4. ANDOVER. H. G. Broadbridge appointed E. & G.M.
" 8. BOLLINGTON. J. Broomhead appointed E. & M.
" 8. BOLSOVER. K. M. Colclough appointed M. & S. vice M. Ford, deceased.
" 14. CANTERBURY. W. J. King appointed S. vice W. A. King, retired.
" 16. CHURNET VALLEY. A. Winton appointed Acting S. vice A. Wrigley, resigned.
" 26. FLEETWOOD. T. E. Parry appointed E. & M. vice W. P. Smith, resigned.
" 68. TRURO. W. J. King, S., resigned.

Institution of Gas Engineers

Members of The Institution of Gas Engineers are invited to attend the undermentioned Meetings:

The Illuminating Engineering Society, to be held in the Lecture Theatre of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W. 1, at 6.30 for 7 p.m., on Tuesday, Dec. 13, 1938, at which a Paper (with demonstrations) entitled "The Response of the Eye to Light in Relation to the Measurement of Subjective Brightness and Contrast" will be read by W. D. Wright, A.R.C.S., D.I.C., D.Sc., and will be followed by a discussion. Admission tickets may be obtained from the Secretary, The Institution of Gas Engineers, 1, Grosvenor Place, S.W. 1.

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A Meeting of the Institution of Chemical Engineers to be held, as mentioned in last week's "JOURNAL," in the Rooms of the Geological Society, Burlington House, Piccadilly, W. 1, on Dec. 31, at 6 p.m. A Paper will be presented by Mr. C. Webb on "Principles of Design of Modern Industrial Furnaces."

News of the Week

An Increase in the price of gas by ½d. per therm for the first 80,000 cu.ft. has been approved by the Johnstone Town Council.

Benzole Recovery is to be practised at Clitheroe, where the Gas Department is erecting plant which is designed to produce 20,000 gallons of benzole per year.

The Institution of Heating and Ventilating Engineers announce a change of address. From Monday onwards all communications should be sent to 22, Russell Square, W.C. 1.

Referring to the Report of the Home Office Departmental Committee on Lighting in Factories in last week's "JOURNAL" we stated that the price of the publication, which is obtainable from H.M. Stationery Office, is 1s., but we omitted to mention that postage is extra.

For the Erection of a Waterless Gasholder, at a cost of over £100,000, the Gas Committee of the Stoke-on-Trent City Council have recommended that the Gas Engineer be instructed to prepare plans and specifications. It is also recommended that tenders be invited for the work.

Fearing that Smoke from the Chimney of a boiler, proposed to be installed at Reedyford Hospital, would be detrimental to the amenities of a nearby housing estate, Nelson Corporation has pointed out to the Hospital Board the advantages of gas, with the result that the Board is to reconsider the question.

"We shall see!" commented the villain, Captain August Lutte, in "Bitter Sweet" at the Cheltenham Opera House, as he twirled his moustachios with malignant glee. But these "Ah, ho! me proud beauty" terms with which he confronted the beautiful heroine, Sari, who had spurned his attentions, were to no purpose. The lights failed.

An Instructive Lecture on "Flame and Its Uses in the Home," accompanied by a series of interesting experiments with flame, was given by Mr. F. Brinsley, M.Sc., of Radiation Ltd., at the showrooms, Leamington, to the showroom and distribution employees of the Leamington, Coventry, and Warwick Gas Undertakings on Nov. 28.

New Gates leading to the Works of the Worcester New Gas Light Company were opened at noon on Friday last by Miss Stallard, daughter of Mr. John Stallard, Chairman of the Board of Directors. After the gates had been declared open all who attended the ceremony were conducted on a tour of the works by Mr. G. P. Mitchell, Engineer and Manager.

When an Electricity Breakdown occurred during a dance at Barwell a member of Hinckley U.D.C., who had been a strong supporter of the Council's scheme for converting the street lighting of Barwell from electricity to gas, took the opportunity of pointing out that had not the change-over been carried out the whole of the district would have been in darkness.

The Mayor of Brighouse, Alderman H. Marshall, formally opened, on Dec. 2, new headquarters showrooms of the Corporation Gas Department. The new premises, in Park Street, comprise main showroom, adjoining kitchen and bathroom displays, large public lecture and demonstration room, and a room devoted especially to demonstrations with reconditioned second-hand domestic gas appliances.

A Lively Debate took place at a meeting of Berwick Town Council last week as to whether gas or electricity should be adopted for housing schemes. Councillor Anderson, Chairman of the Housing Committee, stated that they felt gas was the most economical and suitable medium for cooking, lighting, and heating. After the recommendations had been approved to install gas, an effort to refer the whole case to the Ministry of Health for unbiased advice was rejected.

The Bangor Gas Department had a stand at the Trades Exhibition held in the Dufferin Hall, for the week of Nov. 21-26. There was an attractive display of appliances, including Radiation gas fires, "New World" gas cookers, and Radiation water heaters. The exhibition was extremely well attended and the interest shown in the gas stand was outstanding, it being frequently difficult to get near on account of the number of people making enquiries. The special effort made by this undertaking was very well rewarded by the results recorded.

Overhead Radiant Heaters, by Messrs. Bratt Colbran & Co., Ltd., have been installed by the Boston Gas Light and Coke Company at the new Boston and District Indoor Bowling Club buildings, which will be opened on Dec. 10.

The Benzole Plant at the Perth Corporation Gas-Works is now complete and is in operation. The first consignment of benzole has been dispatched from the works. The equipment includes a rail tank filled by compressed air from the works storage tank of a capacity of 5,000 gallons of crude benzole. The rail tank holds over 10 tons of benzole and this is sent to the central refineries at Falkirk. The yield at Perth has considerably exceeded estimates, and the plant has proved itself capable of extracting over 3 gallons per ton of coal carbonized.

A System of Gas-Electric Lighting has been installed experimentally at North Berwick Station, L.N.E.R. Two single and three double mantle gas lamps have been fitted above the platforms and air is applied by pressure to the lamps, the pressure being obtained by means of a small electric air blower. The single-mantle lamps consume 5 cu.ft. of gas per hour and give about the same illumination as a 100-watt electric lamp. The double-mantle lamps consume 10 cu.ft. of gas per hour and give rather greater illumination than a 150-watt lamp. The lamps are switch-operated.

At the Opening of an Exhibition at Felixstowe on Nov. 28 Mr. G. A. Mallett, General Manager and Secretary of the Ipswich Gas Light Company, announced that from the close of this year the Directors had decided to reduce the rent of all gas cookers by a minimum of 4s. a year. Had it not been for the rise in the price of coal the Directors, he said, would have been able to offer consumers a reduction in the price of gas. They were not able, however, to do this at present. The exhibition was opened by Mr. C. W. Whatmough, Chairman of Felixstowe Urban Council. Mr. A. J. Haward, a Director of the Company, moved a vote of thanks to Mr. Whatmough. Mr. Mallett seconded. The exhibition remained open all last week. There were sound films at 2.30 and 6.45 daily, and cookery lectures and beauty demonstrations each afternoon and evening. The demonstrator was Miss J. E. Ford, of the Radiation Research Kitchen, who used a "New World" cooker.

The Mayoress of Buxton's First Official Engagement was to open cookery demonstrations, which were held in the Buxton showrooms from Nov. 21 to 26. These demonstrations arranged by the Buxton Gas Department, in conjunction with Radiation Ltd., dealt with beauty through the foods we eat. The demonstrator, Miss E. Taylor, of the Radiation Research Kitchen, using "New World" gas cookers, showed her audience how the figure can be controlled through balanced meals, health maintained through well cooked food, and how personal beauty comes from within. In spite of very bad weather, the seating capacity of 160 was filled each evening, a number being unable to gain admission. A cake-baking competition which was run in connexion with these lectures brought in 154 entries, which is a record for Buxton, and prizes for this competition were presented by the Mayoress, Mrs. Smith, on the Saturday evening, at the end of the demonstrations.

On the Invitation of the Glasgow Gas Department, Mr. Leopold Friedman, Assistant Managing Director and Chief Engineer of Ascot Gas Water Heaters, Ltd., gave a lantern lecture on "Water Heating" in the Sauchiehall Street showrooms on Nov. 29. Mr. A. Bujnowski, Chief Sales and Publicity Officer, Glasgow Gas Department, presided over a large attendance which included Councillor E. Rosslyn Mitchell, Chairman of Ascot Gas Water Heaters, Ltd.; Mr. Van de Velde, Sales Manager of the firm; Mr. C. A. Busby, Scottish representative; and representatives of gas undertakings in the West of Scotland. Introducing Mr. Friedman, Mr. Bujnowski said they were fortunate in having the lecturer, who was responsible for the wonderful manuals on water heaters put out by the Ascot Company. Mr. Friedman began by giving an historical review of water heating and bathing in various countries and went on to describe with the aid of an epidiascope the outstanding features in the development of water heating which his Company had introduced.

Board of Trade Announcement

Gas Testing

In accordance with the provisions of Section 12 of the Gas Undertakings Act, 1934, the Office of Gas Referees will be abolished on Jan. 1, 1939, and, save as otherwise provided by the Act, their functions will thereafter be discharged by the Board of Trade at the following address: Board of Trade, Gas Testing Section, Chapter Street House, Chapter Street, London, S.W.1.

Sir Charles Vernon Boys, F.R.S., and Mr. W. J. Atkinson Butterfield, two of the retiring Gas Referees, have been appointed under Section 12 (2) (*b*) of the Act, to advise the Board as to the improvement of the methods and apparatus for testing gas.

Presentation to Professor J. W. Cobb

In connexion with the retirement of Professor Cobb from the Livesey Professorship in the University of Leeds, contributions to the Presentation Fund have been received to the amount of £847. Of this, £583 16s. 6d. was contributed through The Institution of Gas Engineers by its own members, and by members of the National Gas Council and of the Society of British Gas Industries.

It has been arranged to present to Professor Cobb a radiogram and a photographic portrait—a copy of which will be presented to the University and to The Institution of Gas Engineers—and a bound volume containing a list of contributors.

After defraying the incidental expenses of printing and postage, a balance of some £750 will remain. In accordance with the wishes of Professor Cobb, it is proposed to present this to the University of Leeds in order that the income from it may be used to assist students of the Department of Coal Gas and Fuel Industries with Metallurgy to meet the cost of maintenance while at the University or to cover other expenditure necessary for their studies or researches. It is suggested that grants from this fund be made by the University on the recommendation of the Head of the Department.

It is proposed to make the presentations to Professor Cobb on Dec. 9, at 4 p.m. in the General Lecture Theatre of the University of Leeds. Major G. H. Kitson, Chairman of the Livesey Advisory Committee, will preside and ask the Vice-Chancellor to accept on behalf of the University a copy of the portrait and a cheque to inaugurate the Cobb Fund.

Subscribers are invited to attend.

Snow White at Dundee

Snow White and the Seven Dwarfs are still doing their bit for gas publicity. Here is an original treatment of the familiar theme incorporated in an ingenious window display which the Dundee Gas Department arranged to synchronize with the local showing of the famous film.

Tar Roads*

Reviewed by "Tamt"

There are nearly 180,000 miles of roads in Great Britain, some 45,000 miles of which are rated as first and second class. They are used by about three million motor vehicles. Their extension continues. Their maintenance in a condition of high efficiency has become a permanent national necessity. The demands for that purpose must inevitably become more exacting both as to quantity and to quality of supplies. The country is fortunate in possessing a potential source of such supplies in its own coal resources, and the Gas Industry in being a principal means of releasing them. "Tar," say the Authors of this book in their preface, "has played a very important rôle in highway construction in this country, and will undoubtedly continue to do so." Continue, one would suggest, with an upward curve. The fruitful thought and effort which have been expended, especially in the last few years, and of which this book offers the evidence, towards the understanding of the material in itself and in relation to the demands upon it when in use, promise an unrivalled position in the future for gas-works tar for road purposes. And if any be disturbed at the thought of yet another by-product of the Gas Industry assuming more and more the aspect of a staple product, with its own exclusive demands, let him remember the enormous flexibility conferred upon this liquid product by the development of the technique of distillation and blending, following the guidance of research.

The book is opportune. The comparatively recent publication of, for instance, work on thin tar carpets and non-toxic road tars suggested a certain maturity in recent rapid development which might make practicable the publication of a book. We are now provided with an admirable conspectus of the whole subject, authoritative, clear, and up-to-date.

The work is divided into five sections. After a brief historical and statistical introduction, about half the book, Part II., is devoted to road tars themselves. Parts III. and IV. deal with the application of tars to carriageways and footpaths respectively. Part V. deals briefly with the laboratory testing of tar bound materials, and among the appendices are included the standard specifications for road tars used in America and several European countries.

Parts III. and IV., dealing with roadmaking itself, may seem of less immediate interest to many gas engineers, though they include an account of much work—to instance only that on light carpets—which has been brought to fruition largely by the efforts of large gas undertakings. Nevertheless, these sections lucidly fulfil the purpose expressed by the Authors of "enabling the distiller to be familiar with the problems of the road maker." The notes on "faults and troubles" at the end of each subsection are particularly instructive.

But Part II. on "Road Tars" is a badly needed concise account of knowledge scattered through dozens of technical journals, to which references are given for those who need them. The sources, nature and properties, the mode of formation of tar and its physical structure are first discussed. There follows a section on refining and blending, in which all the principal processes in use in this country are touched upon. Non-toxic tars, tar-bitumen mixtures, tar compounds, tar emulsions, and specifications and testing are then briefly, but we think adequately for the purpose of the book, discussed in order. Regarding the notes on "Bitural" under "Tar Compounds," we are under the impression that the success in Australia of this preparation of vertical retort tar is more in accordance with the favourable example which the Authors quote of its use in England than their previous paragraph might imply. Part II. alone makes this book well worthy of the gas engineer's attention.

The main facts and principles of this increasingly important use of tar are set out in plain straightforward language free from irritating technicalities without sacrifice of accuracy of statement. Home-produced tar is evidently holding its own with imported bitumen.

* Tar Roads: A. C. Hughes, B.Sc. (Eng.), A.M.Inst.C.E., W. G. Adam, B.A. (Oxon.), F.I.C., M.I.Chem.E., and F. J. China, B.Sc. (Lond.), F.I.C. XII. + 196 pages, 49 illustrations. London: Edward Arnold & Co.; 18s.

Wind Tunnel Experiments on Model Gasholders

by

S. M. MILBOURNE, M.I.Struct.E.

In view of the fact that the Research Executive Committee of The Institution of Gas Engineers have decided to carry out certain research work in conjunction with the National Physical Laboratory on the stresses in spirally guided gasholders, it may be of interest to describe briefly what has taken place since the late Dr. J. O. V. Irminger carried out his important pioneer work on wind pressure distribution round model gasholders. Many of Irminger's first records were obtained from models placed in a tunnel connected at one end to a chimney shaft; the draught created by the chimney supplied the necessary air current.

The first article by Irminger on wind pressure appeared in the year 1894, and this was followed five years later by a Paper entitled "Wind Pressure on Buildings and Other Structures," which was read before The Institution of Gas Engineers. Other investigators soon followed, among whom the best known were Professor F. K. Th. v. Iterson, of Delft, and A. G. v. Baumhauer. The experiments by Baumhauer were carried out on a model gasholder at the Aerodynamic Station at Göttingen, and the results obtained generally confirmed those of Irminger. These investigations showed that only about one-fifth the area of the holder side sheeting is actually subject to pressure, while the remainder of the sheeting, including the crown, is under the influence of a considerable suction. These experiments, however, were carried out on small models at comparatively low wind velocities.

From considerations of the various physical quantities involved when wind flows past an object in its stream, it may be shown that the form of flow must be a function of the Reynolds number. The Reynolds number may be expressed as a ratio thus:

$$\frac{vD}{\nu}$$

where v = the velocity of the air flow.
D = the diameter of the object (in the case of gasholders).
ν = the kinematic viscosity coefficient of the air.

In order that the distribution of the pressure and suction as ascertained from experiments on model gasholders in wind tunnels shall be absolutely identical with that obtaining on the actual structure when subject to the natural wind, it is necessary that the values of the Reynolds numbers in each case should be equal. This condition represents the law of dynamic similarity.

In the year 1916 Professor G. I. Taylor, when experimenting with a cylinder 6 in. in diameter, found that for a wind tunnel velocity of air at 40 ft. per sec. the distribution of pressure and suction round the cylinder was similar to that found by Irminger, but on increasing the velocity of the air current to 55 ft. per sec. it was found that the intensity of suction in the regions of the cylinder at right-angles to the direction of the wind was very greatly increased. M. Eiffel observed a similar change in the suction on experimenting with a sphere 6½ in. diameter when the wind speed reached 42 ft. per sec. If the value of ν remains constant, it is a simple matter to compare in a general way the diameter velocities vD in feet inches per second. In the case of the changes in pressure distribution cited above, it will be seen that the critical value of the Reynolds number was reached when vD = 240 to 273 ft. in. per sec. The critical value vD = 240 to 950 ft. in. per sec. has since been confirmed for larger diameter cylinders for values of ν obtaining at approximately normal atmospheric temperature and pressure conditions.

In fig. 1 are shown typical forms of wind pressure and suction distribution round a model gasholder for Reynolds numbers above and below the critical value. The hatched lines denote the form of distribution of wind pressure and suction for Reynolds numbers above the critical value, and the dotted lines indicate the form of distribution of pressure and suction for Reynolds numbers below the critical value. As the distribution curves are symmetrical about the axis in the direction of the wind, only half the diagram has been drawn. The intensity of pressure and suction is measured radially from the periphery of the model.

Dynamic Similarity.

Most of the wind tunnels in this country and abroad have been constructed with the primary object of studying the flight performance of aeroplanes or parts thereof. The testing of specially constructed scale models of aeroplanes in wind tunnels presents a different proposition from tests on model gasholders. It is possible in the most modern wind tunnels to achieve absolute dynamic similarity between the model of the aeroplane and the actual machine for flight speeds well over 100 miles per hour. In the case of gasholders, dynamic similarity between the model and the actual structure may be achieved only for very low velocities of the natural wind, on account of the small size of the model when compared with the actual holder.

Experiments carried out in 1934 by Professor J. Ackeret, of the Swiss Institute of Aerodynamics, on a model water-sealed holder 21 in. diameter, with a wind velocity of 100 ft. per sec., show the form of pressure-suction distribution for the highest Reynolds numbers yet obtained in wind tunnels. The

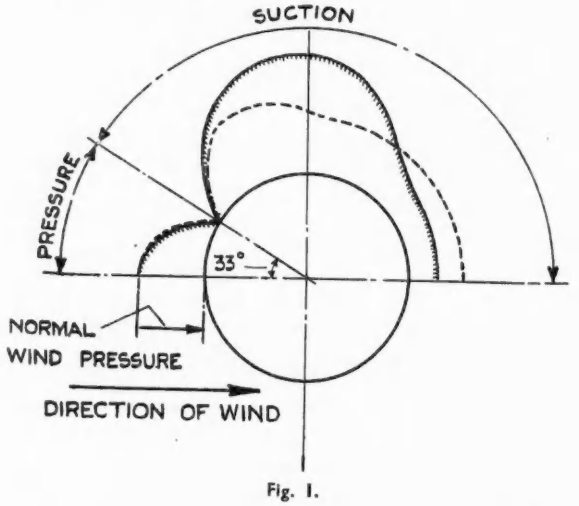

Fig. 1.

value of vD in this case was therefore 2,100 ft. in. per sec., which is well above the critical value, but greatly below the value of dynamic similarity. The model of the holder used by Professor Ackeret was to a scale of one-hundredth full size, so that in order to achieve dynamic similarity between the model and the actual structure for a natural wind velocity of only 56 miles per hour (82 ft. per sec.) the value of the vD would require to be 21 × 100 × 82 = 172,200 ft. in. per sec.

Up to the present time, the distribution of the pressure and suction on the sides and crown of a gasholder has been based on the findings of Professor Ackeret, as the results obtained were at Reynolds numbers well above the critical value. It has been assumed that no change in the pressure-suction distribution round the holder will take place after the critical value of the Reynolds number has been reached. The gap between the values of vD of 2,100 to 172,200 ft.in. per sec. is, however, considerable, and it would be advantageous if experiments on models could be carried out at higher values of vD than those obtained by Professor Ackeret.

Compressed Air Wind Tunnels.

Free-air wind tunnels appear to have reached their practical limits so far as size and wind speed are concerned, but compressed air wind tunnels have been built in which it is

possible to attain much higher values of the Reynolds number. The most important installation of this kind was erected at the National Physical Laboratory in 1931. This tunnel is designed in such a manner that the air may be compressed to 25 atmospheres (368 lb. per sq.in.), after which it can be circulated at a maximum speed of 90 ft. per sec. The object of compressing the air is to increase its density and so decrease the kinematic viscosity v. The area of this tunnel is about 4,070 sq.in. As the profile of a model to be tested should not exceed 6% of the tunnel area, it follows that a model of a gasholder about 15 in. diameter × 15 in. high could be tested in this tunnel. The comparative value of vD, after allowing for the reduction of kinematic viscosity due to compression, would be $15 \times 90 \times 25 = 33{,}750$ ft.in. per sec. The results of experiments on model gasholders at such high Reynolds numbers would be extremely interesting and instructive. The value $vD = 33{,}750$ ft.in. per sec. is equivalent in dynamic similitude to a holder about 64 ft. diameter subjected to a wind velocity of 30 miles per hour. It is doubtful whether high values of the Reynolds number such as obtain in the case of large gasholders under maximum allowable wind velocities will ever be approached in wind tunnel experiments, and the best method of obtaining data relating to the intensity of the wind pressure and suction on gasholders would appear to be from experiments carried out on the actual structure. There are, however, many difficulties to overcome in order that such experiments shall be satisfactory. The delay in waiting for suitable climatic conditions in which to take records, and the fact that much of the apparatus required must be attached to the structure when the test is about to be made, are perhaps the chief difficulties which present themselves. Investigations on wind pressure on chimneys, circular towers, and buildings have, however, been undertaken both in this country and America, and no doubt in the near future similar experimental work will be done in recording the wind pressure and suction at various points on an actual gasholder.

Measuring Gas Temperatures

A Résumé of the Symposium on Gas Temperature Measurement staged by the Institute of Fuel on Friday last, when sixteen Papers on the subject were presented.

Practically every form of industrial or domestic appliance heated by the combustion of fuel either solid, liquid, or gaseous involves at some stage or other the transfer of heat to or from a gas. The measurement of gas temperature is, therefore, a problem of profound importance to most sections of industry, and not least to the Gas Industry. The operation of retorts in which gas is produced and the operation of appliances and furnaces in which gas is used depend essentially upon the utilization of gas in the form of products of combustion, or, at an earlier stage in the process, of burning producer gas, of burning water gas, or of burning coal gas. It is not often realized how difficult is the problem of determining the temperature of a gas that is not in complete thermal equilibrium with its surroundings. It might be supposed, for example, that if a heated gas is flowing through a pipe or flue the temperature of the gas will be obtained by putting a thermometer or thermocouple in the gas stream. This apparently simple operation is, however, hedged about with so many pitfalls that it would be safe to take very long odds against this method giving even an approximately correct indication of the true temperature of the gas. There is so much confusion in industry generally in regard to this question of gas temperature that the Institute of Fuel is to be congratulated upon staging the comprehensive discussion upon the whole subject which was comprised in the 16 Papers discussed at the all-day meeting which was held on Dec. 2 last.

When the gases are in a condition of thermal equilibrium there is, of course, no difficulty; and whatever may be the method by which the temperature is measured, if that method be correctly applied the results will be accurate. In practice, however, technical processes involving the use of gas at temperatures above atmospheric very seldom involve conditions of thermal equilibrium. Dr. Fishenden and Dr. Saunders in their Paper pointed out that the main sources of error in measuring the temperature of a gas by means of a thermocouple or thermometer inserted in it are (1) the exchange of radiation between the thermocouple and the surrounding walls, (2) the conduction of heat along the thermocouple leads, and (3) the lag between the thermocouple and the gas temperatures when the gas temperature fluctuates.

There is, of course, another perhaps more fundamental type of error which was discussed in a Paper by Mr. J. G. Bennett and Dr. Pirani. This Paper contained much abstruse phraseology, but in brief may be summarized as expressing the well-known fact that the energy of a gas may take many forms, such as the kinetic energy of molecular movements; the energy of excited electronic states of atoms, molecules, and free radicals; the energy of rotation of molecules; the energy of vibration of the nuclei; and the potential energy of such modifications as ionization or dissociation. All these may absorb more or less of the energy of combustion, so that thermodynamic equilibrium is not obtained, part of the energy being "trapped" in forms which do not appear as temperature. Likewise the energy of a gas may be carried in various forms. For example, the temperature of a neon lamp deduced from the mean energy of the electrons appears to be in the order of 15,000° C.; if the energy of excitation is used as the measure, a temperature of 10,000° C. is indicated; while if the energy of ionization is measured the temperature is returned as 12,000° C. The actual temperature of the gas in the lamp—which is in the form of kinetic energy of the molecules—is, however, only 50° C.

Technical Problems Involved.

Likewise when the gaseous products of combustion pass through a water-cooled chamber, the water vapour and carbon dioxide will be cooled to a lower temperature than the nitrogen because of their greater emissivity, and at high velocities this may have technical importance where there is a marked stratification of the gases resulting in paralleled streams, alternating between rich in nitrogen and poor in water vapour and carbon dioxide, and the reverse. These Authors, therefore, point out that it is important to decide which are the physical magnitudes which might be taken as indicating temperatures of real importance from the technical standpoint. It is, for example, of no particular interest for the technical man to know the temperatures of acetylene flames, blow-pipe flames, electric-arc welding flames, and so on. He will desire to know the temperature attained on the weld, which depends on the physical properties of the metal, on the combination of atoms on or near the weld, and on losses by gas convection. When the engineer calls for a determination of these temperatures it is necessary to visualize clearly the technical problem involved. The scientist will thus very often realize that he has to study the engineer's problems very much more thoroughly than he previously thought necessary.

Correcting for Errors.

The greater part of the discussion on the Papers of the Conference was concerned with the practical measurements of gas temperatures in the light of the sources of error pointed out by Fishenden and Saunders. These Authors

showed how the errors in gas temperature determination can be corrected by calculation, but perhaps the practical importance of their mathematical treatment lies for engineers in the light thrown upon instrument design in regard to the conditions under which correct readings can be obtained. The calculation involves equating the heat transfer between the gas and the couple by convection and gas radiation to the heat transfer between the couple and the walls by radiation. It was shown that as the diameter of the thermocouple decreased, the temperature registered becomes more nearly the true temperature of the gas because the area available for radiation exchange between the thermocouple and the walls decreases. Mr. W. R. Hawthorne pointed out that in boiler practice the radiation transfer between a body approximating to gas temperature and the cool surface surrounding varied from 700,000 B.Th.U. per sq.ft. of (*e.g.*, thermocouple) surface per hour in the hot portions of the heating system to almost zero in the air-heater. The difference in temperature between the gas and the surrounding surfaces is thus a second fundamental in the problem. Since the area available for radiation exchange is a governing factor, it is evident that in the limiting case of a measuring instrument—thermocouple or thermometer—of zero diameter, the true gas temperature will be indicated under all conditions. As the diameter increases the thermocouple reads farther from the gas temperature. This leads to a method which several authors agreed was accurate—namely, the use of three thermocouples of different known diameters, one being as fine as possible; the true reading as registered by a hypothetic thermocouple of zero diameter is determined by extrapolation from these three readings. Care must be taken in inserting the three thermocouples that none of them screens any of the others, and one method of doing this, described by Mr. M. W. Thring, which would eliminate all shadow effect, was to place the couples in a line at right angles to the gas flow, and as far apart as possible.

The mathematical analysis also showed that a thermocouple gives readings more nearly correct as the velocity of the gas stream increases until at infinite velocity (similarly to zero diameter) the thermocouple would read the true gas temperature under all conditions. The converse of this is also true—namely, that it is very difficult indeed to obtain the true temperature of a gas not in thermal equilibrium and moving with low velocity. This is important in instrument design. The principle of the importance of low difference in temperature between the thermocouple and its surrounding surfaces leads to another valuable practical method of temperature measurement. This method, which is frequently used in practice to reduce the radiation errors in thermocouple readings of gas temperatures, is to surround the couple with a shield to prevent it from "seeing" the walls of the enclosure. The shield then takes up a temperature somewhere between the thermocouple and wall temperatures, and the thermocouple may be regarded as being surrounded by walls at a temperature nearer to the gas temperature than before. The error in measuring the gas temperature is thus reduced. Calculation has shown that both thermocouple and shield should have a low emissivity in order that they should lose as little heat as possible to their surroundings. A good deal of very valuable information was published in the Papers concerning the design of instruments based on this principle, and it was shown that when properly designed they should give correct results. Emphasis was placed on the desirability of using a shield of low emissivity, and of using two or more concentric shields. For use at hotter temperatures the radiation shields around the thermocouples will be relatively poor conductors of heat, and in order to avoid lag during temperature changes the shield should consist of thick walled cylinders of very porous insulating refractory. For lower temperatures the shields will be made of metal. In most of these instruments arrangements are made for further improvement by arranging for an increased gas velocity over the thermocouple, the instrument being then termed a suction pyrometer or a flow pyrometer.

The Suction Pyrometer.

Dr. Schack contributed an elaborate mathematical analysis of the suction pyrometer to the discussion. The errors in measurement of these pyrometers were calculated and were found to amount to over 200° C. when the true temperature of the gas was no higher than 800° C. The interchange of radiation with the surroundings is so great that even at moderate temperatures the ordinary suction pyrometer is subject to errors of the order of 40° C., whence it follows that this type of suction pyrometer is almost useless for temperatures over 1,000° C., where the radiation increases sharply without any increase in the heat transmission by convection. Theory showed that the results obtained with suction pyrometers with two or more concentric suction tubes give much better results. Only the small tube suction pyrometer in which the thermocouple is surrounded with two or three rows of narrow tubes, through which the gas to be measured flows at a high velocity, yields really useful results, according to Dr. Schack. Practical measurement carried in a flame tube boiler showed that the results arrived at theoretically were borne out in practice, and that the theory may be used for the calculation of corrections for high temperature measurements. Some authors, however, found that the suction pyrometer was clumsy, and preferred to use three thermocouples of varying diameter. Apparently, both types give good results when properly applied.

Errors due to conduction of heat along the thermocouple leads should be minimized by making the portion within the hot gas as long as possible and by using wires of as small a diameter as is feasible.

Fluctuating Gas Temperature.

Another phase of the subject that may be of importance on occasion is the measurement of a fluctuating gas temperature. If the temperature of a gas fluctuates, a thermocouple, owing to its finite heat capacity, will not follow the gas temperature instantaneously. The lag will, of course, depend upon the frequency of the fluctuation, if periodic. Fishenden and Saunders showed mathematically how this fluctuation could be followed by correct design of the thermocouple. One obvious way of increasing the sensitivity is to decrease the heat capacity of the thermometer or thermocouple—and consequently the conduction along the sheath, which is often only possible at the expense of robustness—or to use the bare wires, but this is seldom possible because of the corrosion and contamination that inevitably occur. Thus the indicator used in practice where it is protected by a metal or refractory sheath is generally a compromise in this important respect. A very useful method for increasing sensitivity is sometimes employed, which consists of welding the tip of the thermocouple to the bottom of the protecting metal sheath. This has been found of great value when measuring exit gas temperatures from water-gas generators where the temperature fluctuates rapidly. The problem is complex because if the gas contains any radiating constituents, such as water-vapour or carbon dioxide, the response will be quicker than that calculated. The couple, moreover, will exchange radiation with the walls of the enclosure, and this may either shorten or lengthen the time of lag according to whether the fluctuation brought the gas temperature further from, or nearer to, the wall temperature.

Enough will have been said to show that in these Papers on gas temperature measurement, the Institute of Fuel has provided industrialists with a wealth of information that may well be the standard authority on the subject for a long time to come.

A.R.P. at Leeds

Remote Control of Gasholder Station

Arrangements whereby the Manager and staff of the New Wortley Gasholder Station may carry on in safety during an air raid have been perfected by the incorporation of an Ediswan Loudspeakerphone installation.

During the wiring of the equipment for normal intercommunication service, provision was made in the wiring for each unit, including the master, to be removed to various bomb-proof shelters where remote control apparatus for operating the gasholder station has been installed. Thus, the entire organization can be transferred to safe positions and work go on uninterrupted.

Under normal conditions, the master unit is connected to a seven-pin multi plug, and this is connected to a seven-pin baseboard type valve holder. In one shelter there is also a seven-pin baseboard into which the master can be plugged, the two holders being connected in parallel.

The changeover has been timed to take three minutes.

AUTUMN RESEARCH MEETING OF

The Institution of Gas Engineers

In our issue of Nov. 23 we published the bulk of the written contributions to the discussions on the Papers presented at the Autumn Research Meeting, and the Authors' replies. The following completes all the written contributions and replies.

Some Results Attained with Solid Fuels Used in Open Grates for Heating Living Rooms

Communication No. 200

by

W. DAVIDSON, B.Sc., Ph.D.,

and

HAROLD HARTLEY, D.Sc.,

Central Research Laboratories of Radiation Limited

The Authors' Reply.

The AUTHORS, in reply, wrote: Our sincere thanks are due to all who have taken the trouble to contribute to the Discussion of this Communication, and especially to Dr. Smith for his remarks in opening the debate. As was to be anticipated, the views expressed are to some extent contradictory, as many of them represent deductions from experimental results.

We are pleased the Paper has proved of such interest and, as it appears to have stimulated general consideration of the room heating problem, our primary object has been fulfilled. It is gratifying also to find that our further application of the integrating radiometer has had such a sympathetic reception. The use of a number of radiometers adds about 10 per cent. to the cost of the apparatus.

The following notes are presented by way of comment on points of criticism made in the Discussion, specific reference to the contributor being omitted to shorten the reply:

The fuels examined were supplied by various undertakings or organizations. It was not anticipated that the comments on the results summarized in Table 2 would have been regarded as having reference other than to the particular fuels tested. The chief object of this Section was to record the open grate performance of fuels having the physical and chemical properties given in Table 1.

In drafting the Paper we endeavoured to weigh the evidence impartially, and to indicate, where necessary, the limitations applying to our deductions. Some of the points seem to have been raised because of incomplete appreciation of these qualifications.

Bulk Density.

In designing a coke grate, due regard is taken of the relatively low bulk density of the fuel. In test 1 (Figure 1) the fire was refuelled once in a period of burning extending over 10 hr., whereas in test 12, with a coke of low bulk density, refuelling was only necessary after a 3-hr. period, despite the relatively high emission of heat. A similar size of modern barless stool coal grate would be filled with 10 lb. of coal, and the attainment of the same heat output would necessitate replenishment in 3 hr. It is, of course, true that for lower heat outputs, large coal can be used, and the fire can be made to burn longer than a coke fire. The quantity and nature of the ash varies in coals just as it does in cokes. We have indicated in our Paper that small quantities of "fines," present in coke supplies, can be utilized in the manner suggested for coal slack. We would emphasize that in comparing fuels the appliance in which they are used cannot be ignored. With a coke grate and its gas ignition system, kindling can be effected easily and the rate of burning controlled quite well by the use of the air slide, permitting regulation of the output of heat more readily by one possessing little skill, than when bituminous coal is burned in a typical fireplace.

In general, of course, the higher the bulk density of a fuel, the less frequently is stoking necessary. Especial reference is made to the great advantage of high bulk density in a domestic solid fuel, in connexion with Figure 3, which shows in graphical form the results attained with an anthracite and a Welsh steam coal. The latter fuels were tested in two gradings, the 1 to 2½ in. size being that recommended by the producers, and since reported to be most suitable by Dr. Fishenden in her Paper on "Welsh Smokeless Coals for Open Fires." It would seem that the onus of proving that the results quoted in regard to them are unfair still rests with our critic.

In all tables except 6 and 7 we have recorded the unburned fuel left in the grate and in the ash-pan, and in the computation of the "useful fire" and overall radiant efficiencies allowance has been made for the fuel remaining on the bars, as it is normally used again. The arguments for or against the use of bituminous coal, *vis-à-vis* coke, are not affected appreciably by consideration only of the overall radiant efficiencies attained.

In the light of our experience we should reject, as liable to be inaccurate, claims as to radiant efficiency based on observations taken at a single position in front of a fire. Further, it is essential that the measuring apparatus used must be such that the results attained with it are not influenced by effects arising from variation in the temperature of the air or of the walls of the test room.

"Useful Fire."

The suggestion that a standard output of 8,000 B.Th.U. per hr. should be used in definition of a period of "useful fire" does not stand critical examination. There are many occasions when an output of 5,000 B.Th.U. per hr. or less is required from a 16 in. grate. Any endeavour to assess a period of "useful fire" must take account of the average intensity of emission required for comfort under the conditions of use.

The moisture content of the coke is of first importance; an increase in the moisture content from 5 to 10 per cent. will often cause a 20 per cent. increase in the time required to attain a bright fire, both when kindling and after refuelling. In addition, more gas will be needed for ignition.

If an unsuitable type of grate is used for the less combustible fuels, such as the high-temperature gas cokes and the anthracites, poor fires radiating at very low rates and with low efficiencies would be attained.

The efficiency figures we have quoted, and the deductions we have made from them in regard to the relative cost of operating the different fires, have been both commended and criticized in the Discussion. Apart from independent calibration of the individual radiometers, we used a gas fire of

known efficiency for a check calibration of the integrating radiometer, so that if there were an error in our absolute values, this ought not to influence the comparative figures.

Our test procedure with a bituminous coal fire has been modelled on the common practice of the consumer, and a bright fire was attained from cold in 30 to 40 min. We have based our comparative costs of heating on consideration of the requirements of the living room of a working-class home, where, for several months of the year, a fire is burned for over 6 hr. per day, and even up to 14 hr. In the present state of knowledge, any assessment of an allowance which may be thought permissible consequent upon the greater flexibility of gas must largely be a matter of opinion. We agree that gas should have a credit. At the same time, ordinary people do not operate their domestic fires as would be done under the conditions of a laboratory test, whether they use coal, coke, or gas. When the emission of heat from a gas fire is greater than is really necessary for comfort, the gas should be turned down, but sometimes a user is content to move his or her chair to a position more remote from the source of heat. Thermostatic control could be applied to prevent such misuse.

Over-ventilation may be as objectionable as under-ventilation, and in general there is a reduction in the amount of air passing up the chimney of a room when a hearth-type gas fire is fitted in front of a coal grate. The consequent reduction in air flow would operate in favour of gas heating, from the point of view of cost. The suggestion that a true appreciation of the economic position can best be attained by making comparative tests in suitable rooms, in an endeavour to simulate domestic practice, is very attractive at first sight, but consideration of the possible variants raises doubt as to whether the results attained would be really more reliable than deductions made from straight efficiency tests.

The maker endeavours to produce a grate suitable for burning different grades of gas coke, and in the best types of gas-ignited coke grates even the most unreactive gas cokes can be burned, although with a slower rate of kindling and recovery of the fire than when more reactive fuels are supplied. It is essential, however, and especially in the case of unreactive cokes, to ensure that the amount of moisture present, and the ash content of the fuel shall be low. In our Paper we have stressed the point that the nature of the ash is important.

With larger sizes of cokes we found the fires were only bright in the heart of the charge, the coke on the top and in the front remaining dull and screening heat radiated from the incandescent portions. The condition of burning may lead to an increase in the chimney loss.

The fastidiousness of the domestic coke user and the need for careful control of the quality of the fuel was rightly emphasized by one of the speakers. Cokes supplied in different parts of the country vary much in their characteristics, and this has to be appreciated fully when designing a suitable grate.

We have already indicated that we regard high bulk density as a desirable property in an open grate fuel, but of even greater importance is ease of ignition. The most popular cokes of to-day are fuels of low bulk density which can be ignited easily.

We have not found the performance of a coke fire to be affected by sudden changes of chimney pull, such as would occur with a gusty wind, but would emphasize that the canopy opening in our test grate is some 22 in. above the hearth level.

The pitch coke we examined gave no noise when burning. The cause of noisy burning seems worthy of investigation, since we have had a number of cokes which, although reactive, were unsuitable because of the noisy manner in which they burned in the grate.

The results we attained with the low volatile Welsh coals were good, and reference has been made earlier in these comments to the fact that with this fuel in a coke grate, long period fires can be produced. We did not get satisfactory results with anthracite used in a standard modern barless stool grate, since the capacity of the grate is too low. We feel that a deeper bed of fuel is required, and that a front bar would need to be fitted to make the coal grate suitable.

The Production of Free-Burning Coke in Continuous Vertical Retorts

Communication No. 199

by

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and

J. G. KING, B.Sc., Ph.D., F.I.C.,

Chief Chemist, Fuel Research Station, Department of Scientific and Industrial Research

Mr. H. J. TOOGOOD (Hampton) wrote: The basic thought underlying this splendid co-operative research is that if a town desires low-temperature, free-burning smokeless fuel, then its own gas-works is the right and proper source of supply. The complementary Paper, on "Some Results Attained with Solid Fuels Used in Open Grates for Heating Living Rooms," brings out, as never before, the magnitude and the importance of the factor of the particular design of grate.

In studying the commercial aspect of this new free-burning coke, let the data and calculations be never so accurate, there remains always one unknown factor, the man in the street—and success depends on the reaction of this individual to the new fuel, so much so that I am constrained to enquire if the Authors will in their good time carry their co-operative efforts into an educational practice, by arranging two open fires, burning side by side, in easy view from the window of the Edinburgh Gas Showroom, so that the man in the street can, by contrast of performance and relative costs, form his own unaided opinion:

1. A coke grate burning the Edinburgh normal continuous vertical retort coke.
2. An ordinary household coal grate burning the Edinburgh free-burning, low-temperature coke.

The Authors' Reply.

The AUTHORS, in reply, wrote: A number of the Contributions to the Discussion have referred to the price of 36s. per ton, *ex* works, at which it was stated this free-burning smokeless fuel could be supplied. The figure is only arbitrary and was determined by the price at which gas was produced in Edinburgh during the year 1937. It is expected that a much higher price is obtainable and, indeed, tentative enquiries have indicated that there is already a market for solid smokeless fuel in Edinburgh which will pay 60s. per ton of fuel delivered. The *ex* works price corresponding to this would be 50s. per ton. Mr. Richards raises an important point when he states that careful and systematic cultivation of the demand for a new product is essential and also that the article should be of uniform quality.

Mr. Richards and Mr. Hunter raised the question of the utilization of stand-by plant. That must vary according to the policy practised in different undertakings. In Edinburgh, for instance, it is customary to keep under slow fire a large number of retorts, the letting down of which would damage the refractories. Throughout the summer months, and to a lesser extent in winter, these are available for emergency purposes. At the expense of a slightly additional expenditure on coke these retorts can be used for the production of

this special fuel. The maximum production will be in the summer when the demand for coal is small and provision has been made for the storage under cover of at least 2,000 tons of smokeless fuel. It is anticipated that until the sale of the fuel exceeds 20,000 tons, the surplus retorts will be able to cope with the production. If the demand grows to the extent which we think it should, then it may be necessary to put down special plant, but in this case the fuel will require to carry the capital charges involved. If, as Mr. Hunter mentions, 2s. per ton suffices, production should be more than self-supporting.

The remarks by Mr. Astbury on the production of "Dryco" are encouraging and are very helpful to one of us (J. J.) who is now faced with the problem of using upwardly-heated vertical retorts. Already substantial quantities of coal have been treated in 103 in. major-axis upwardly-heated retorts and the smokeless fuel produced does not differ in any way from that produced in the 73 in. downwardly-heated retorts. Retort temperatures, however, require to be much more carefully controlled and the smaller retort is a better unit for the purpose.

Failure of Top Courses.

Mr. Astbury raises a very important point about the abnormal failure of top courses of retorts, leading to the complete destruction of the bricks, and expresses the opinion that this was due to alternate tar penetration and subsequent carbonization at the relatively low temperature conditions prevailing at that point. In Edinburgh similar trouble has been experienced under normal working conditions of high-temperature carbonization and in fact has been most troublesome with the downwardly-heated retorts when using temperatures in the region of 1,400° C.

So far no deterioration is apparent in the upwardly-heated retorts, and at the Fuel Research Station experiments have been carried out with retorts heated at relatively low temperatures, also without any difficulty of this kind. Mr. Astbury thinks 4·5 per cent. of volatile matter is too high, and prefers a maximum of 3 per cent. We can agree with him regarding the latter if the coke is to be burned in a coke grate but not, as in our case, when we postulate its use in coal grates even of the well-type. As he realizes, the ignition qualities of coke containing 3 per cent. of volatile matter are not particularly good. They cannot be improved by altering the bulk density of the coke, and it has yet to be proved that the addition of alkalies is not deleterious to retort brickwork. As regards this vexed question, Mr. Astbury's experiments at Liverpool should be most helpful. Mr. Astbury mentions that no credit has been taken for the extra tonnage of smokeless fuel at 36s. and the reduction in the amount of coke exported at, say, 20s. per ton. The export price of coke under the International Export Association is at present 27s. per ton f.o.b. The export market varies from season to season and for that reason we agree that we should have been justified in taking this factor into account in computing the economic value of the preparation of solid smokeless fuel to a Gas Undertaking which has to resort to export to rid itself of surplus coke produced at high temperatures.

Mr. Boon indicates that notwithstanding the satisfactory performance of special coke grates there was a very large potential market for a first-class low-temperature coke. That opinion seems to be general, and in view of the public interest taken in the investigation carried out at Edinburgh we subscribe to the opinion expressed by Mr. Boon and feel that it is a question which the Gas Industry cannot afford to ignore.

We agree with Mr. Hunter that special grates will go a long way in popularizing high-temperature gas coke for domestic heating purposes, but we also feel that for many years to come a ready market will be found for a reasonably cheap free-burning solid smokeless fuel. Mr. Hunter mentioned a loss of 25 per cent. in the therm output of the plant when operating at the lower temperatures. The guaranteed therms per retort per day for the retorts used in the investigation were 620, and in Table 4 the yield from coal A was 656 and 548 from coal B. We are of the opinion that in actual production the gaseous output of a plant need not be adversely affected by the production of smokeless fuel from coals of the description given in the Paper. We are aware of the danger pointed out by Mr. Hunter of special coals rising rapidly in price once a demand is created, but feel that if the smokeless fuel is prepared in the summer, when the demand for coal is limited, that would offer a certain amount of protection. The smokeless fuel is hard and not easily broken and will stand storage and handling very satisfactorily.

Mr. Boon's observations on the radiation from fires are most helpful and we do agree that the rate of pick-up could be improved even more. We do not agree, however, that the pick-up of our cokes compares unfavourably with the gas cokes described in Technical Paper 46, since these were burned in a different type of grate and are not comparable. Perhaps we are less fortunate than Mr. Boon in our experience of the C.A.B. test, but we have generally found that the results of this test are difficult to construe and less definite than those of our more practical test in which the coke is dealt with in its full size. In the early stages of our work we did try Northumberland coals and we can say that these will give as satisfactory medium-temperature fuels as the Scottish coals experimented with in detail.

We do not agree with Mr. Branson that the cokes A and B compare unfavourably with low-temperature cokes. Fuel A, while being slightly slower than the standard low-temperature fuel used at Granton in reaching an intense fire, gave a much higher rate of radiation and a much longer period of intense fire, factors which are of considerable importance.

The prices stated, 28s. 6d. and 36s., quoted for both high and low temperature coke, include cutting, screening, storing, de-breezing, and loading into trucks and bags. It is true, as Mr. Branson points out, that no allowance was made for the ¾ to ¼ in. size of fuel produced by the high-temperature process, the reason being that coke breeze with this size removed would be unsaleable. If the ¾ to ¼ in. size were sold separately, even at a higher price than that taken for the smokeless fuel, the revenue per ton for the high-temperature process would actually be less than that shown in Table 11. In saying that the grade ¾ to ¼ in. in the case of our special fuel is particularly suitable for the closed stove we are speaking from experience, since we have found over a considerable period of time that reactive material of this type is particularly suitable for the closed stove both as regards ease of control, regulation of temperature, and efficiency.

Breeze Production.

Mr. Branson also refers to the percentage of breeze shown for the high and low temperature processes. It should be pointed out, however, that treble and double nuts were used in the case of the latter, whereas the normal practice in Edinburgh is to use screened coal which has to be broken, and in this way a high percentage of small coal results. These smalls are advantageous for packing the retort, which is desirable when using low-caking coal if a reasonably high yield of gaseous therms is to result. The quantity of breeze produced, however, is much higher than if high-caking coal or size smalls were used. The quantity of breeze quoted in Table 11 for the smokeless fuel was the actual amount produced, the coke being treated in exactly the same way as that normally used in the high-temperature process at Granton. The trebles and doubles were, however, put through the coal breaker as no by-pass was available, so that the quantity of breeze produced may have been higher than it would have been had more satisfactory handling conditions existed.

Mr. Ritchie states that in medium and smaller works no stand-by retorts are as a rule available and in that case the special fuel could only be prepared by installing additional retorts for the purpose. If special coals were selected and care exercised in carbonization we are of the opinion that a reasonably good smokeless fuel could be produced by using normal retort temperature and speeding up the travel of the coal. The fuel would not be so consistent in quality, however, and the danger of uncarbonized coal passing through the retort would be very great. The ash of Scottish coal does present a difficulty, but many of the coals used for household purposes contain ash of a similar or even worse type than that of coals A and B.

Mr. Dixon mentions some of the difficulties which operating the dual process presents, but these are really not

so serious as he anticipates. The fuel is at present being produced in Edinburgh and the process is operating alongside normal gas manufacture. No new plant of any description was necessary and, as already stated, will not be necessary until production exceeds 20,000 tons per annum. The four end retorts of an installation of 24 in. upwardly-heated 103 in. continuous vertical retorts are producing 30 tons per day of free-burning smokeless fuel, the remaining retorts working under ordinary gas making conditions. The retort temperatures are approximately 1,000° C. at the top and 1,150° C. at the bottom. A slight adjustment of the steaming arrangement controls the calorific value of the gas and so far none of the anticipated difficulties mentioned by Mr. Dixon has arisen. The percentage of steam used in the tests at Granton was the minimum at which we care to operate the retorts and on that account was purely arbitrary. We do not think that the steam influenced in any way the structure or behaviour of the low-temperature fuel, although we are of the opinion that in practice only the minimum quantity of steam should be used. The points raised by Mr. Mitchell and Mr. Pearson have been already covered, but we wish again to state that the success of the process depends entirely on being able to find a market for the fuel at a price sufficiently high to compensate for the increased costs involved.

We are interested in the remarks made by Mr. Toogood on the commercial aspect of this new free-burning fuel and on the desirability of educating the public on relative costs and suggesting that a coke burning grate and a grate using the new fuel should be installed in the Edinburgh Gas Department Showroom. One of us (J. J.) had already made provision for such a scheme and one showroom in a prominent part of the city has been adapted for the purpose. Special grates burning ordinary and graded coke have been installed and an ordinary fireplace has been provided for the new free-burning fuel, and, in addition, a closed stove for the burning of smalls for the heating of water.

The exhibit will be complete and will be officially opened by the Lord Provost and other prominent citizens on Dec. 14, 1938. This will coincide with a special show of the Gas Industry's new films and an official luncheon to prominent people interested in the abatement of smoke.

Quality Control and A System in Operation

By

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A Paper before the Southern Association of Gas Engineers and Managers held in London on Friday, Nov. 25.

(*Continued from p. 703 of last week's* "JOURNAL.")

For economy the examinations may be carried out in a number of ways:

(*a*) A complete and detailed or major examination of the whole production or delivery, although, as a general rule, this is not common except with very small consignments.
(*b*) A complete and detailed examination of only one sample or of a percentage of samples, selected at random, and in addition a superficial or minor examination of the remainder.
(*c*) A complete and detailed examination of one or a small percentage of samples only.
(*d*) A superficial examination of the whole production or delivery.
(*e*) A superficial examination of one or a percentage of samples only.

Where examinations are made outside the factory it is not always easy to decide the number or percentage of samples to be selected, owing to the comparatively small numbers involved, or to the irregular intervals between small deliveries, and in these cases it is usual to select a suitable number of samples on a basis of:

(*a*) A percentage of samples from all consignments.
(*b*) A sample or samples from a given percentage of the consignments received.
(*c*) A percentage of the number of articles distributed.
(*d*) A periodical selection of samples.

In the system under consideration it is found necessary, owing to the large variety of goods, variation in quantities, and other reasons, to adopt a combination of all four methods. To ensure that this is systematically applied, some form of testing instructions must be available to the testing assistants before any work is started

Automatic Review of Testing Work.

As each consignment of goods is received, advice is sent by the Storekeeper to the Testing Section where card indices are kept containing Testers' Information Cards for each appliance and other item of store, and each maker of them.

For convenience in filing and handling the more detailed comments on appliances, the cards vary in lay-out. The card for materials and fittings, however, explains more fully the general system. One side of the card contains instructions regarding the percentage and degree of testing to be observed, specification or schedule reference number, yearly usage, and any special points to be observed in carrying out the tests. The other side contains information regarding the cost of item and results of examinations of previous consignments. (See page 16.)

All routine deliveries thus come under constant review, and by the systematic use and periodical revision of this card index as a result of experience and previous tests recorded, the whole of the system can be kept flexible and it is possible to economize in, and eliminate a great deal of otherwise unwarranted work, and to concentrate in more profitable directions.

District Liaison.

Apart from the Main Stores there are over 50 smaller local stores attached to the various district departments on the Company's area. The necessity for maintaining direct contact with these and with the district personnel attached to them is met by the employment of several senior testing assistants engaged solely for this purpose. Their duties include:

(*a*) examination and classification of part worn, obsolete, damaged, or surplus stock;
(*b*) periodical inspection of district equipment and fitters' tool kits;
(*c*) examination of defective goods at consumers' premises;
(*d*) examination of outside contractors' material on site and at their stores; and
(*e*) co-operation with Stores Department in developing suitable methods of handling, storing, transporting, and using the Company's Stores.

It is necessary, in addition to the economic regulation of

sample testing, to have some system permitting the constant review of the cost of the actual testing work, and a Combined Job and Test Result Sheet is used, and to save time in preparation and reporting, this test sheet is carbon-backed for duplication, thus ensuring simultaneous and immediate advice to the store and other departments concerned of the acceptance or action to be taken.

Costing Systems and the collection of statistics themselves necessarily cost money and so often with time become merely dead records. The most economic and efficient system is one that presents regularly and periodically only the essential details, but permits, *as and when required*, the easy extraction of the maximum amount of useful data.

Quality Classification.

The Job and Test Result Sheets contain in logical and sequential order details of the consignment and exactly what the tester finds in respect of each test applied. In order that he himself may feel some of the responsibility for the ultimate decision, he has to append quite separately, in the form of a summary:

(*a*) His conclusions and reasons.
(*b*) His recommendations and reason for acceptance or otherwise.

The Result Sheet is finally scrutinized and the goods classified by a Senior Testing Assistant and endorsed with any comments necessary for the Buying or Store Departments or for transmission to the Manufacturer.

One of the most difficult tasks for the Senior Testing Assistant in the handling of these results is to make a decision on a border line case. There is a fallacious belief that with any specification there can be only two courses of action, either acceptance or rejection. In view of manufacturing difficulties and of the need for economy, specifications cannot always be absolutely rigid, the "pious hope" clauses containing such vague and indefinite phrases as "reasonably free from," or "approximately equal to," have to be used. In all commercial and mass produced articles there may be minute variations which constitute deviations from this standard without necessarily affecting the ultimate performance. The value of the article, the cost of transport in the event of rejection, the urgency of issue, and the value of amicable trading relations all have to be considered.

In order to avoid disputes and misunderstandings, the usual method of classifying these reports is:

(A) Acceptance as satisfactory.
(B) Acceptance but constructive criticism on minor details forwarded to maker.
(C) Acceptance under protest and maker warned of definite discrepancies.
(D) Rejection with reasons.
(E) Comment for information of Stores Buyer and Stores Superintendent only.

Whenever possible, any action with manufacturers is taken immediately after the goods have been examined, and, when desirable, with representatives of the Store and Testing Staffs present.

Owing to the Company's wide technical interests and the large variety of goods purchased, it has been found necessary, to avoid confusion, for the Testing Section to deal directly with the manufacturers in technical matters coming under classifications "B" and "C." Discussion with makers is encouraged, and cards pertaining to, and giving a complete record of, their goods are open to their inspection at any time. This has worked well in practice, and manufacturers appear to appreciate the efforts of the section to assist them in these problems.

Co-ordination of Defects and Failures.

The chief object of the system, described in the following pages, is to ensure, as far as possible, that the goods purchased by the Company will give satisfactory service over a reasonable number of years, and require no undue or excessive attention from either the Company or consumer. This will protect the Company's reputation, and eliminate the expense and inconvenience which are an inevitable result of defects which arise between maintenance visits.

It must unfortunately be accepted that, however much care is taken in the design and production of an article, and however elaborate the testing system employed, defects, failures, and complaints will still occur.

MAKER. SPENCER.
APPLIANCE. EVEREST COOKER 1937.

	ISSUE		DEFECT. Leaky float taps, due to poor machining of plugs.	Broken plate rack arms due to faulty material.	Defective enamel on castings.	Excessive condensation from oven.	Thermostat out of calibration.	Hotplate bars unsteady; warped.									Total (Carried Forward)	Lab. Initial.
Mth.	Mth.	Cum.																
Jan.	200	200	2				4										6	JCS
Feb.	200	400	3			1	3										7	JCS
Mar.	200	600	1				1										2	JCS
Apl.	200	800					1										1	JCS
May.	100	900																JCS
June.	150	1050	1					2									3	JCS
July.	100	1150					1	1									2	JCS
Aug.	150	1300																JCS
Sept.	150	1450	1	1													2	JCS
Oct.	200	1650		1			1										2	JCS
Nov.	200	1850																JCS
Dec.	200	2050																JCS
Totals	2050		8	2		1	11	3									25	JCS

Defects Summary Card.

This applies to all new types and designs of machinery, appliances, and materials, and equally to all industries. The cause in this case is often the inability of the designers to give sufficiently extensive and lengthy trials under the greatly varying conditions of use before producing in bulk. It is this knowledge of behaviour under actual conditions of use that is so valuable to the Laboratories and Manufacturers, and which can be used to promote economy and progress.

With modern methods of production it is actually possible for large numbers of items to be issued and in use before a certain fault becomes apparent. This is a serious point, and illustrates the need for a system which will render swift and effective action possible in such circumstances.

Most failures fall under seven definite headings:

(*a*) The use of unsuitable or inferior materials.
(*b*) Poor mechanical or other treatment.
(*c*) Careless assembly.
(*d*) Unsatisfactory design.
(*e*) Local conditions.
(*f*) Curiosity and interference on the part of consumer.
(*g*) Faulty installation, use, or maintenance.

The Gas Light and Coke Company last year installed some 700,000 appliances and its maintenance staff made over one-and-a-half million service inspections on appliances installed in the Company's area. With such a wide variety and large number of goods, defects and failures are likely to be both serious and costly unless some form of control is employed.

In general the knowledge of a defect and of the basic cause of failure should be the means of its elimination. It is often thought that this knowledge can be obtained from statistics and returns compiled from information given by a large number of people having little or no knowledge of analysis, varying degrees of technical knowledge, widely differing views as to what constitutes "fair wear and tear," and lacking the ability or means to carry out any systematic investigation. Certainly, information can be obtained in this way, but it is limited, often unreliable, and the cost of obtaining it is out of all proportion to its value.

The most desirable method is, whenever possible, for those constantly handling the goods in examination to see the defective article, discover the cause of failure, co-ordinate the information, and discuss the matter in its proper perspective with the maker.

This method is proving of great value to the manufacturers, since first hand and reliable facts regarding the behaviour of their goods in use are essential to progress, and not easily obtained by other means. They not only express their appreciation, but usually are anxious to replace genuinely defective goods at their own expense.

The Testing Section is responsible for collecting from the

widest field all possible information on Defects. This is obtained by:

(*a*) Encouraging the staff and fitters to notify all defects observed. A note is forwarded to the Testing Section by the mechanic and a duplicate is attached to the article which is then returned to the Main Depôt from which it was issued. These defects are compounded, and examined regularly by members of the Testing Section; any article considered worthy of a further and more searching examination being returned to the Testing Laboratory.

(*b*) Liaison with outdoor district staff, stores, depôts, and repair shops by travelling Stores Inspectors.

(*c*) Examination of all goods returned for repair.

(*d*) Direct questioning by the Training Staff.

Experience is necessary in order to distinguish between exceptional and unavoidable manufacturing errors and definite defects due to avoidable causes. It is often even more essential when defining "fair wear and tear" in terms of years of useful life, and it is here that this method proves superior to a wholly clerical system. Information is obtained from the widest possible field, is checked and investigated by trained and reliable technicians working in close co-operation with the makers, and is fully recorded and available to all concerned.

Three sets of cards exist giving:

(*a*) Full details of laboratory examination of any defective goods returned from district.

(*b*) A monthly summary of all defective goods returned to Stores.

(*c*) A monthly summary of all new fittings and materials which are tested on a large scale, with details of the quantities, rejections, criticisms, and general quality of the consignments.

By means of this index system it is possible to tell at a glance the general quality and behaviour of any one item. The Materials and Fittings Summary Card will indicate the quality of the item when received from Maker; the Defects Card will give details of trouble occurring when the item is in use, and the Defects Summary Card will indicate the number of defects which occur each month.

Maker TAYLOR — Consignments — Defects - Items

Appliance: ½" B.S.P. galv. M.I.Elbows.

Date	Issue Mth	Issue Cum	A	B	C	D	E	No Threads.	Poor Threads.	Leaky.	Poor Galv.	Eccentric Threads	Split.	Total (Carried Forward)	Lab. Initial
Jan.	1000	1000	4	-	-	-	-	1	-	4	4	-	-	9	/6
Feb.	1500	2500	5	-	-	1	-	2	1	2	250	-	-	255	/6
Mar.	1500	4000	6	-	-	-	-	1	2	-	-	-	-	3	/6
Apl.	2000	6000	7	-	1	-	-	2	1	-	-	-	-	3	/6
May.	2000	8000	7	-	-	-	-	-	-	2	-	5	-	7	/6
June.	1000	9000	4	-	-	-	-	-	-	1	-	1	1	3	/6
July.	1000	10000	2	-	-	-	-	-	-	2	-	-	-	2	/6
Aug.	1500	11500	5	-	-	-	-	-	-	1	-	1	-	2	/6
Sept.	1500	13000	4	1	-	-	-	-	1	-	-	-	4	5	/6
Oct.	2000	15000	8	-	-	-	-	-	-	1	-	1	3	5	/6
Nov.	2000	17000	8	-	-	-	-	-	1	1	-	-	-	2	/6
Dec.	2000	19000	4	-	-	-	-	-	1	1	-	-	-	2	/6
Totals	19000	-	64	1	1	1	-	6	7	15	254	8	8	298	/6.

Materials and Fittings Summary Card.

In conclusion, I should like once more to emphasize the need for general co-operation, which appears to me to be the whole keynote of efficient testing. There should be regular meetings of the senior members of Testing Staffs to discuss internal problems, and general policy. In the interests of industry and progress every effort should be made to keep the practical viewpoints of those actually testing, installing, servicing, and using the goods constantly before those actually carrying out research. The closest contact should be maintained with the buying and storing departments, and the Testing Section should always be ready to give immediate advice or help in the interpretation of specifications and technical matters concerning the use of goods. A careful check should be kept on each item, from the laboratory stage through the manufacturing stage, to the final stage when the item is in use; the views of the research worker, the maker, the salesman, the workman, and finally the user should all be considered, and should play a part in deciding improvements and the severity with which that item need be tested. I feel that by this means only is it possible to effect successfully the economic and efficient quality control of so large and varied a quantity of goods as that purchased by The Gas Light and Coke Company.

Discussion.

Mr. C. Le Maistre, C.B.E. (Director of the British Standards Institution), opening the discussion, observed that Mr. Dunkley was a very valued member of several of the B.S.I. Committees, and consequently it was not only an honour to be invited to open this discussion, but also a great pleasure. He, the speaker, had noticed in his travels—and he had travelled a good deal—how differently standardization was carried out in different countries. Here, as some of them knew, a standards organization was started in 1901 with one Committee of eight; to-day there were over a thousand committees with 18,000 members. All that work represented time and experience freely given by engineers, architects, chemists, and business men all over the country, and represented also an immense amount of indirect assistance to national movements. Thus he thought that so far from going downhill, they would realize that this country was very much alive. Mr. Dunkley's Paper was symptomatic of the growing interest of industry in the organized use of statistical methods in the sampling and analysis of goods. Many organizations kept records but failed to make the fullest use of them. If they were properly compared and applied they could be of the greatest value in the revision of specifications. In some cases, of which the Gas Light and Coke Company was a shining example, individual inspection was economically possible; but in the majority of cases they had to fall back on sampling and be satisfied with that. In such cases one had to be sure that the sampling was carried out in such a manner and to such an extent that the inspection of the samples would give a fair indication of the bulk of the consignment. In making Specifications, instructions were given for the selection of samples, and it would sometimes be found that, if two failed to pass, the whole consignment would be rejected. This was an arbitrary decision, with no statistical reason behind it: but it was all that could be done at the moment. Work such as Mr. Dunkley was developing was helping to replace these arbitrary clauses by routine tests based on statistical methods.

Continuing, Mr. Le Maistre remarked that Mr. Dunkley had spoken of quality control from the user's viewpoint or the supplier's viewpoint. The British Standards Institution was slowly introducing a standard mark which manufacturers were using under licence; they were introducing a system of quality control and routine tests which was designed to be of the highest value in maintaining quality. This would be invaluable to the home and export trade; competitive buying made a testing system of some sort absolutely essential, and it was difficult to imagine how any store-keeper could function without it. How could he assess the value of the appliances which came before him? Such a system would be most valuable in reducing the cost of maintenance; and when one had several thousand fitters and mechanics on maintenance one was dealing with very big figures. Mr. Dunkley's Department must be in possession of knowledge that no one else could obtain, and he was therefore pleased to see that makers applied to Mr. Dunkley to inspect these very interesting test sheets; these must be a mine of information to the manufacturers.

Mr. F. A. W. Oliver (Superintendent of Supplies to the Metropolitan Water Board) said that Mr. Dunkley and he had collaborated for many years. It was very helpful for the water authority to have an opportunity of collaborating with those who handled such a multitude of fittings which might be a serious cause of waste and contamination. It would not be difficult for them to appreciate, dealing with the side of the subject with which he was most familiar, that unsuitable water fittings were a source of waste. They could deal with root causes best by a system of finding them out before they occurred rather than afterwards. They had in many cases succeeded in getting makers to alter their designs fundamentally for the purpose of obtaining better service and better wear. The results had been somewhat notable. There were two ways of regarding this question of quality control. It enabled them to maintain the quality of the fittings; interchangeability prevented waste in the replacement of worn parts; and it also prevented contamination.

Mr. C. H. Rutter asked if Mr. Dunkley's work dealt with engineering supplies, such as bolts, nuts, rivets, steel bars, and so forth.

Mr. S. E. Whitehead (Southampton) suggested that the Paper would have been still more valuable to most of them if there had been a few more specific details on the application of these methods. They were all so very small in comparison with the Gas Light and Coke Company, and a system that they might consider essential for their own organization might be regarded as an expensive luxury to most of them. It all came down to a question of cost. Mr. Dunkley said that the expense of testing

was more than balanced by the savings effected. They must accept the fact that testing on such a scale paid the Gas Light and Coke Company, but it would be very interesting and helpful to know what the cost amounted to. He appreciated that it must vary considerably from one appliance to another. Then there was the vexed question of sampling; this probably occurred to most of them with greater force than it did to the Gas Light and Coke Company. It seemed to Mr. Whitehead that this question of testing could be sub-divided into individual testing of every item in a consignment or a certain percentage of every consignment. In the average undertaking there was much to be said for individual testing of every item. The majority of undertakings tested every wrought-iron fitting and pressed cock and ensured that no defective fitting got on to the district. An alternative to testing every fitting was to warn manufacturers that one was testing a certain proportion, and that one would apply the results of those tests by rejecting a consignment that did not come up to standard. There was much to be said for the individual testing of all fittings, and he would welcome Mr. Dunkley's views on this point; it was not quite clear whether he tested all fittings or applied the sampling method to all deliveries. He appreciated that Mr. Dunkley's tests had the effect of proving the quality of deliveries, and enquired what system was applied to appliances. Was every appliance tested under gas load? Mr. Dunkley had indicated that the bulk of the testing was carried out by boys of 14 and 15 in their probationary year of apprenticeship. Mr. Whitehead's experience was that such boys would be of little use for testing, and he would have thought it better to employ apprenticed fitters in their fourth year. He also enquired what tests were applied to wrought-iron tubes. Were torsion tests included and were the tubes subjected to a pressure test either individually or by sample, or were the manufacturers' certificates accepted in such cases?

Tests for the Smaller Undertaking.

Mr. G. LE B. DIAMOND (Folkestone) asked if Mr. Dunkley could give those in smaller undertakings some idea of the way in which they could carry out rough and ready tests by which they could reject fittings outside any possibility of acceptance. There was also an element of danger in this matter—which did not, of course, arise with manufacturers of repute, but which, nevertheless, had happened. They could imagine the manufacturer who had on his hands consignments of goods rejected by the Gas Light and Coke Company sending them somewhere else. How could they easily size up the deliveries they were receiving?

The PRESIDENT (Mr. D. C. Cross, of Lea Bridge) said that Mr. Dunkley had pointed to the need for co-operation with smaller undertakings; he had described the exhaustive tests of the Gas Light and Coke Company, which had left them with the reflection that there was a danger of those smaller undertakings receiving their "throw-outs." He had heard it said that the Gas Light and Coke Company required a higher standard than others. This raised the question of whether the smaller undertakings could not co-operate more and obtain more benefit from these tests. The manufacturer was very fortunate in having available reports on the defects of his apparatus. Such information would be very valuable to other gas undertakings if they could have, for example, a central clearing office where records of defects were tabulated. Smaller undertakings might have greater difficulties than the Gas Light and Coke Company, and it might be rather startling if smaller undertakings could send in their defects to a central office; these would be of much value. Mr. Dunkley had emphasized that information must be swift, as otherwise a large quantity of defective apparatus might be distributed before it was found out. If anything went wrong on the district it was returned to the undertaking involved, and the undertaking had to maintain that apparatus. Therefore, quality control was of great importance to the undertaking because it affected the good name of the undertaking as well as their maintenance work. Was there any possibility of extending this quality control so that the smaller undertaking could take advantage of the work of Mr. Dunkley's Department?

Mr. R. ROBERTSON (Bristol) wondered whether the solution of the problem lay in the transfer of sampling and testing to the manufacturers' works, so that a suitable brand could be affixed before the goods left the works as a guarantee of quality. He believed this idea had been put into practice in Canada and the United States, and he would like to know whether Mr. Dunkley had any views on that subject. Although Mr. Dunkley's work applied a very rigid test to all materials and apparatus passing through the hands of the undertaking, did it touch the apparatus, workmanship, and fittings provided by outside contractors? Did Mr. Dunkley tackle this problem and, if so, in what way?

Mr. P. E. BROWNE (Brighton), proposing a vote of thanks to Mr. Dunkley for his Paper, observed that this was another example of the Gas Light and Coke Company's "big brother" attitude to other members of the Industry. Having applied their systems successfully, they were ready to place them at the disposal of others. It was very timely, for quality control and testing were most necessary to the Industry to-day. They were selling not gas but gas service; he would stress that if there was any defect in an appliance the quality of the gas was criticized rather than the apparatus.

Mr. A. H. ANDREWS (South Metropolitan Gas Company) seconded the vote.

The Author's Reply.

Mr. DUNKLEY, in reply, said how much he appreciated the kind remarks which had been made. The interest shown in the Paper was an ample recompense for any time which he had spent in its preparation. He said in reply to Mr. Rutter that the testing system did embrace tools, engineering materials, and accessories generally—in fact, all materials that the Company purchased.

Mr. Whitehead referred to the position of smaller undertakings in relation to control of quality. This had been brought to his attention many times and he had frequently commented on defective and inferior materials which had been sent to him through the Domestic Centre. This was a general problem and it appeared to him to be one which definitely required consideration, if only from the viewpoint of reducing maintenance costs. As regards the cost of the work, as pointed out in his Paper, most National and Industrial Specifications to-day embodied simple and easily applied tests specially designed with the object of providing economical testing and which could be carried out with a minimum of skilled labour.

Several speakers had raised the question as to whether detailed information was available regarding methods of testing, and the more common weaknesses likely to be encountered in goods handled by gas undertakings. Mr. Dunkley said that he had had this in mind for some time and was actually in the process of compiling this information.

He hoped he had not been misleading on the question of individual and sample tests. He carried out very little individual testing to-day, relying to a large extent on the guidance given by the previous history, the percentage of defects in samples from new deliveries, and by district defects. Providing adequate and suitably selective sampling was carried out, he felt that a rigid control could be maintained. Where individual testing was carried out it was solely with the object of ensuring gas tightness on items which were liable to be porous or give trouble in that direction, or where safety was of prime importance. It was this class of work, which was comprised almost entirely of soundness testing, that was carried out by the boys in their early days of training as apprentice fitters. The knowledge gained in the handling of these materials and fittings was in a large measure concurrent with the first year of the gas fitting syllabus.

Manufacturers were required under The Institution of Gas Engineers Regulations governing the installation of gas supplies and appliances to carry out individual soundness tests but often were not in a happy position owing to the difficulty in obtaining young labour and subsequently finding outlets for them as they become older. It would be economically impossible to test appliances individually, as the cost of unwrapping and suitably re-wrapping would in many cases be prohibitive, and Mr. Dunkley said that he relied, therefore, on a very complete and detailed examination of a suitable number of random samples selected from stock.

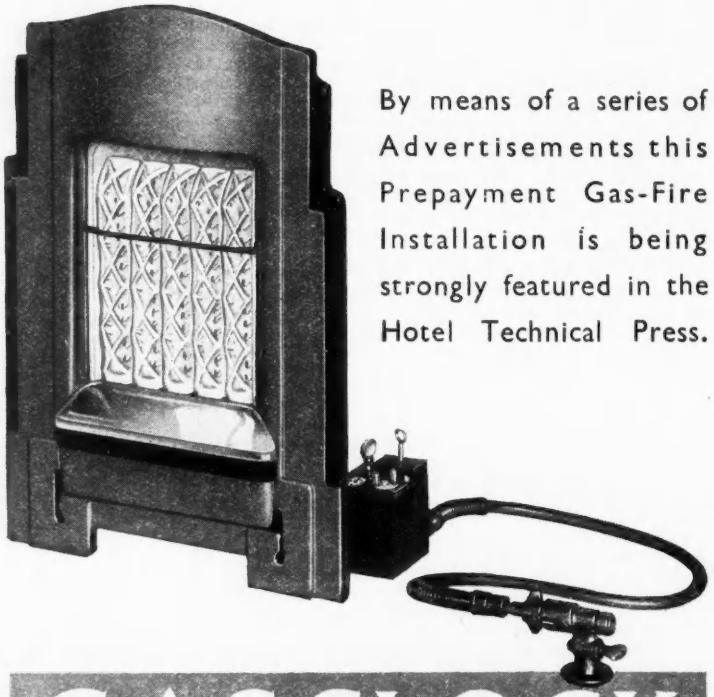
Time did not permit his giving details of the tests carried out on mild steel and wrought iron tubing, but he would be very glad to send details to any member requiring them. As regards the opening of the weld, he felt that generally speaking the welds were good to-day but were often opened in the screwing process. This was due to the tubing protruding too far from the vice and allowing excessive torsional deformation, and to the use of unsuitable or blunt dies.

The President had also mentioned the question of general co-operation. Mr. Dunkley said that he agreed entirely and felt that further development should be carried out in this direction. He felt that during discussions one always gained as much as one gave, and much valuable information could be obtained by discussion and co-operation between interested parties and makers.

In replying to Mr. Robertson, Mr. Dunkley said that testing was required to be carried out by manufacturers and that this testing work was inspected periodically. Generally speaking, manufacturers tended to rely on process testing rather than on the finished product. Frequent visits were paid where necessary and this approximated very closely to the system carried out by the B.S.I. in which their inspectors periodically visited makers' works, and where, provided everything was satisfactory, the makers were permitted to apply the B.S.S. mark to their products. Despite this, widely varying percentage of defects were still found.

Replying to Mr. Robertson's reference to contractors' material, Mr. Dunkley stated that for many years he had been responsible for the quality of materials used by contractors. Not only were visits paid to their stores at regular intervals, but samples were selected on the sites during installation and subjected to detailed examination.

The GASCLOCK is being brought to the notice of the owners of Hotels and Boarding Houses



By means of a series of Advertisements this Prepayment Gas-Fire Installation is being strongly featured in the Hotel Technical Press.

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A few of these units will cover the heating requirements of many bedrooms. Easy to carry about—total weight, approximately 20 lbs.

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Enquiries will be directed to local Gas Offices. You can assist the cause of Gas by having a GASCLOCK Unit in your Showrooms. Literature sent on request.

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London Office and Showrooms: 48 Grosvenor Gardens, S.W.1 ● Glasgow Office and Showrooms: 82 Gordon Street

TRADE NEWS

"Camalite" Coal Fire Lighter.

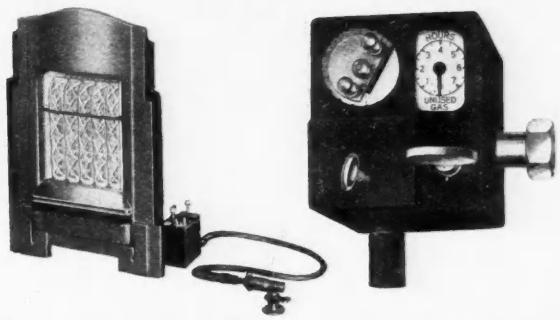
We have already referred in the "JOURNAL" to the smoke-reducing coal fire in which ignition of the coal is effected by the play of powerful gas jets on the upper surface of the fuel. Messrs. William Edgar & Son, Ltd., have now put on the market a portable gas lighter, the jet of flame from which plays on the top of the coal charge. Our illustration shows the appliance in action, and it will readily be understood that the gas flame consumes smoke as it is formed and provides a source of warmth during the lighting-up period. Every model is supplied with a safety bayonet connector and is adjustable in height to suit any type of grate. The new lighter—named the "Camalite"—should prove very popular and provide the Gas Industry with added consumption.

"Lister" Air-Cooled Engines.

An illustrated leaflet giving interesting and useful details of "Lister" air-cooled engines has been published by Messrs. R. & A. Lister & Co., Ltd., Dursley, Gloucestershire. Among the advantages claimed for the air-cooled type is that it is considerably lighter than the water-cooled. For example, the ABL 1½/3 h.p. engine weighs only 68 lb. complete with accessories. This is especially important where weight is a big factor in portable machinery used for such purposes as agriculture, concrete mixing, welding plant, industrial, and A.R.P. equipment. Positive cooling is obtained by powerful air circulation from blower type flywheel fan to all parts of cylinders and heads. These engines are claimed to operate efficiently for continuous duty under extremely high and sub-zero temperatures. In frosty weather it is entirely free from damage by freezing. Lister engines are used the world over for all purposes where heavy duty is required, and have a reputation for their ability to stand punishing service.

Portable Prepayment Gas-Heating for the Hotel Guest.

The "Gasclock" is claimed to be the neatest and most compact prepayment gas-heating device ever patented. It operates by means of its time-clock and a sixpenny-piece. The time set for the sixpence can be varied between a quarter of an hour and four hours and any unused period may be cancelled. The time-clock, which is British-made and claimed to be thoroughly reliable, can also be supplied as an independent unit for use with "fixed" types of gas fire. In the illustrations, which have been sent us by the makers, Messrs. R. & A. Main, Ltd., the "Gasclock" is seen both separately and attached to a portable fire. A few such units would cover the heating requirements of many bedrooms. The total weight of such a unit is approximately 20 lb.



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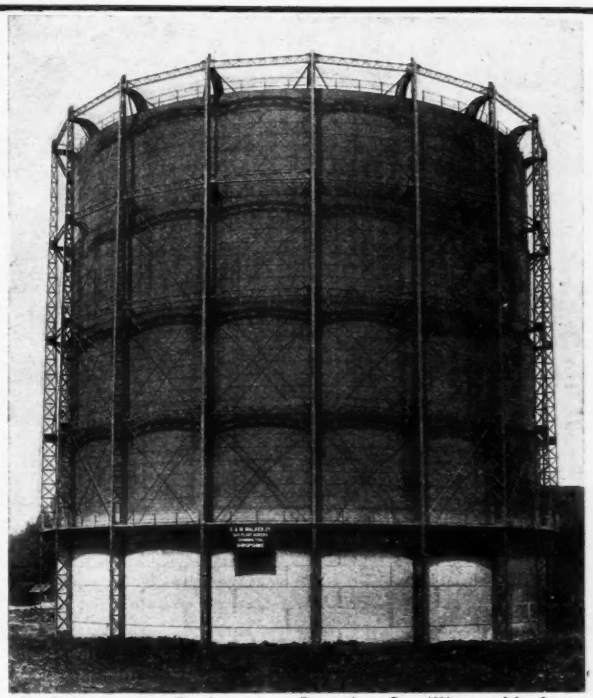

At Belper, near Derby. Capacity, 2 million cubic feet.

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GAS PURIFIERS

Our illustration shows the purifier installation at the new Wincobank Works of the Sheffield Gas Company. It is designed to deal with 12,000,000 cubic feet per day and comprises 12 purifiers measuring 40' square by 6' 6" deep.

Our long experience and the high standard of our work has earned for us the leading place amongst manufacturers of Gas Works Plant. Our Technical Staff is at your disposal for the preparation of schemes and tenders to meet your special requirements.

Other specialities are Gas Cleaning and Washing, Benzole Recovery, Ammonia Products, Gasholders, Tanks and General Iron and Steel Work.

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Markets and Manufactures

Current Sales of Gas Products

The London Market

LONDON, *Dec.* 5.

There is little change to record in the value of Tar Products in the London market, to-day's values being as under:

Pitch nominal at about 30s. per ton f.o.b.

Creosote, about 4d.

Refined tar, 3¾d.

Pure toluole, about 2s. 3d.

Pure benzole, about 1s. 9d.

95/160 solvent naphtha, 1s. 7d. to 1s 8d.

90/160 pyridine, 10s.

All per gallon naked at makers' works.

The Provinces

Dec. 5.

Crude Gas-Works Tar, 15s. to 20s.

To avoid misunderstanding, it is necessary to state that the above price is not claimed to represent a market value. It is a price worked out from week to week upon a system which has been used for many years as a basis for the fixing of certain contracts for crude tar of varying qualities in different areas.

The average prices of gas-works products during the week were: Pitch—East Coast, 31s. to 32s. f.o.b. West Coast—Manchester, Liverpool, Clyde, 31s. to 32s.* Toluole, naked, North, 1s. 7½d. to 1s. 9d. Coal tar, crude naphtha, in bulk, North, 7¾d. to 8¼d. Solvent naphtha, naked, North, 1s. 4½d. to 1s. 5d. Heavy naphtha, North, 1s. 2½d. to 1s. 3d. Creosote, *ex* works, in bulk, North, liquid and salty, 4⅜d. to 4⅝d.; low gravity, 4¼d. to 4½d. Carbolic acid, 60's, 1s. 7d. to 1s. 10d. Naphthalene, £13 10s. to £16. Salts, 70s. to 75s., bags included. Anthracene, "A" quality, 4½d. to 4¾d. per minimum 40% purely nominal; "B" quality unsaleable. Heavy oil; Unfiltered anthracene oil, min. gr. 1,080, 4¾d. to 4⅞d.; filtered anthracene oil, min. gr. 1,080 5¼d. to 5½d.; heavy tar oil, gr. less than 1,080, 4½d. to 4¾d.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be necessary to deduct the loading costs and the tolls whatever they may be.

Scotland

GLASGOW, *Dec.* 3.

There is still a decided lack of new business being placed, but makers' quotations show no material alteration during the week.

Crude gas-works tar.—Actual value is about 35s. to 36s. per ton *ex* works in bulk.

Pitch remains difficult with plentiful supplies available at 22s. 6d. to 23s. 6d. per ton f.o.b. for export and 20s. to 22s. per ton in bulk for home trade.

Refined tar.—No change has taken place in the home price at 3¾d. to 4d. per gallon, and for export quotations are keen at round 2¾d. to 3d. per gallon, both into buyers' packages at makers' works.

Creosote oil.—Some substantial orders have been placed during the week and, if anything, market is steadier as under: Specification oil, 4d. to 4¼d. per gallon; low gravity 4¼d. to 5d. per gallon; neutral oil, 4d. to 4¼d. per gallon; all *ex* works in bulk.

Cresylic acid.—Any orders being placed are for small quantities and values are as follows: Pale, 97/99%, 1s. 2d. to 1s. 4d. per gallon; dark, 97/99%, 1s. to 1s. 2d. per gallon; and pale, 99/100%, 1s. 4d. to 1s. 8d. per gallon; all according to quality *ex* works in buyers' packages.

Crude naphtha readily commands 5½d. to 6d. per gallon *ex* works in bulk, according to quality.

Solvent naphtha.—90/160 grade is 1s. 3½d. to 1s. 4d. per gallon and 90/190 heavy naphtha is round 1s. 1d. to 1s. 1½d. per gallon.

Motor benzole is 1s. 3d. to 1s. 4d. per gallon.

Pyridine.—90/160 grade is 8s. to 9s. per gallon and 90/140 grade is 9s. to 10s. per gallon.

Benzole Prices

These are considered to be the market prices for benzole at the present time:

	s.	d.		s.	d.	
Crude benzole..	0	9½	to	0	10	per gall. at works
Motor „ ..	1	3	„	1	3½	„ „ „
90% „ ..	1	4	„	1	4½	„ „ „
Pure „ ..	1	8	„	1	8½	„ „

New Capital Issues

Redditch.

The offer for sale by tender of £20,000 Ordinary Stock of the Redditch Gas Company was three times over-subscribed. Tenders ranged from the minimum of 120 up to 134. The average price obtained was £126 6s. 10·08d.

Leamington.

The Leamington Priors Gas Company has decided to create a further 1,000 "C" Ordinary shares of £20 each, carrying a maximum dividend of 7% per annum. These shares are being offered in the first instance for subscription by the existing shareholders at a premium of £10 per share.

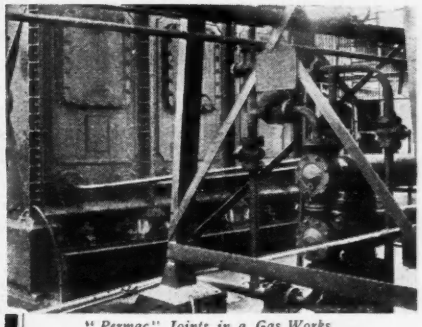
Troon Gas Department

In his annual report Mr. J. W. Beveridge, Engineer and Manager to the Troon Corporation, states that the make last year was 76,498,263 cu.ft., an increase of 1,342,770 cu.ft. over the previous year, and sales totalled 71,720,800 cu.ft., an increase of 1,360,777 cu.ft. Income was £18,954, against £17,568. Expenditure under net revenue account was £14,792, an increase of £1,265, and expenditure for general administration, rates, &c., £3,202, a decrease of £179. A surplus balance of £4,162 is carried forward to net revenue account to meet annual standing charges. Yield of gas per ton of coal carbonized was 17,509 cu.ft., an increase of 80 cu.ft.

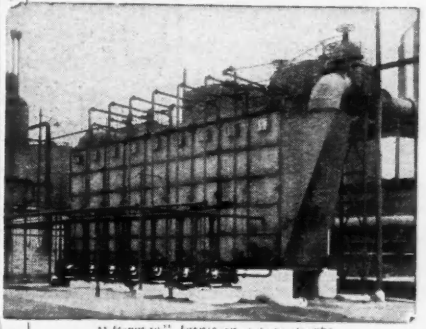
There's only one

Permac!

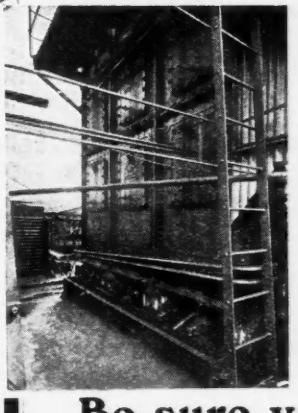
METAL-TO-METAL JOINTING MATERIAL.



"Permac" Joints in a Gas Works



"Permac" Joints in a Gas Works.



"Permac" Joints in a Gas Works

Be sure you get it!

Here is a selection of "Permac" joints photographed in various Gas Works. "Permac," the Metal-to-Metal Jointing, has been holding up difficult joints like these for over 25 years. Send for particulars.

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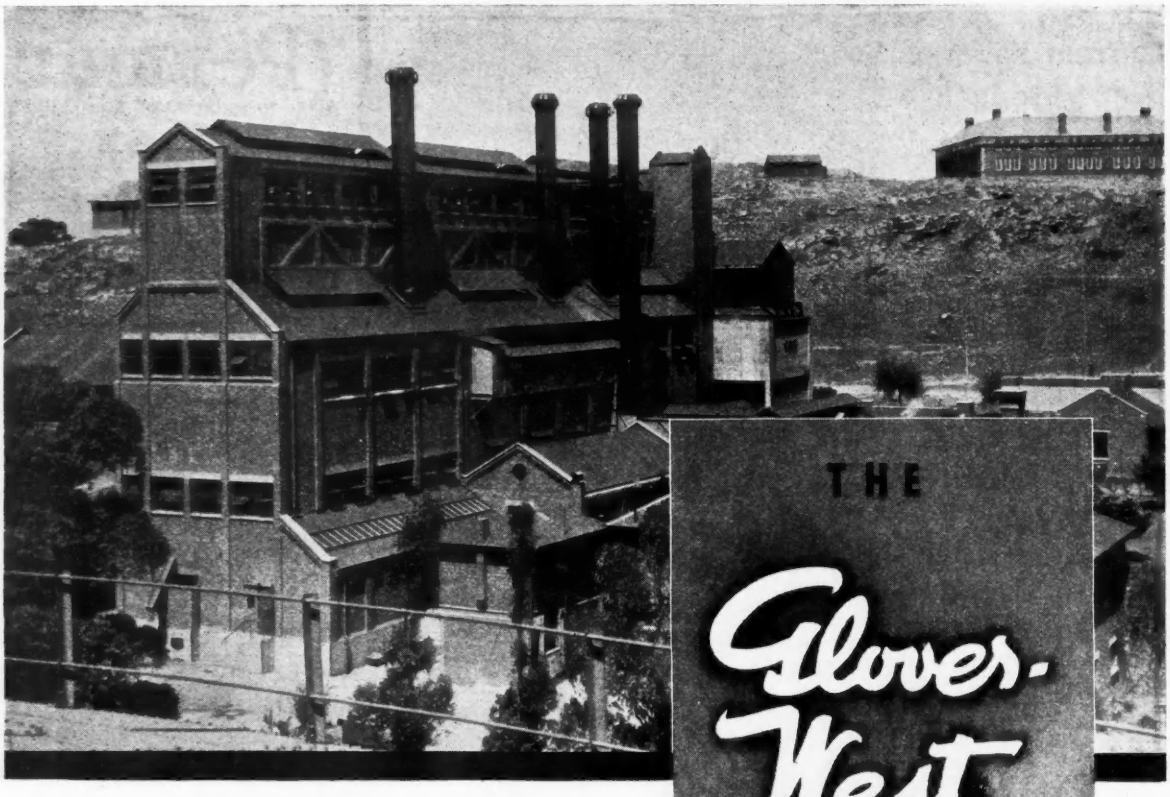
● CARBONIZATION IN VERTICAL RETORTS



The modern Glover-West vertical retort plant has behind it the accumulated experience of 64 years' constant research and development for the advancement of gas production methods the world over.

● *430 plants have been built or are on order for 230 Gas Undertakings in 24 countries.*

The picture shows the three installations of Glover-West vertical retorts at Johannesburg City Council's Cottesloe gasworks. The carbonising unit of the complete modern gasworks ordered for Johannesburg from this company in 1926 has been trebled to meet the rapid growth of demand. The latest extension put to work in 1937 is nearest the camera.

●

WEST'S GAS IMPROVEMENT CO. LTD.,

MANCHESTER: Albion Ironworks, Miles Platting ■ LONDON: Columbia House, Aldwych, W.C.2

GAS STOCKS AND SHARES

Sir John Simon's announcement that he intended to ask Parliament to extend the existing borrowing powers and the failure of the French General Strike were two factors which at one time gave a more optimistic tone to the Stock Exchange last week. Towards the close, however, much of the better outlook was lost on account of Italy's unofficial demands on France. The Chancellor's statement had a good effect on gilt-edged securities and British Funds after a depressing opening began to harden. Home rails, on the other hand, failed to maintain the advantage gained the previous week and several closed a point or so down. There were a few bright spots in the industrial section, though on the whole business was on a small scale, and in the absence of any speculative buying prices varied little either way. The mining market was heavy in tone and prices fell, while oil and rubber shares also weakened.

It is gratifying to note that the increased volume of business in the Gas market recorded during the previous week was followed up with an even greater display of activity last week. Prices, therefore, though showing no tendency to make an all-round improvement have been steadily held, but in only a few instances show any upward tendency. Gas Light units were in good demand and closed 3d. higher at 22s. 9d., and it will be seen in the list below that apart from the hardening of some fixed-interest stocks other quotations remained unchanged. Several fractional gains took place at the Provincial Exchanges, including Liverpool and Sunderland ordinary stocks, while nominal quotations in the Supplementary List remained unchanged.

For investors requiring safety-first holdings to give a return slightly above gilt-edged securities gas debenture stocks have much to commend them, and a number of large parcels are available at the present time. The list of those on offer includes £50,000 Associated Gas and Water 3½% at 96½ free, giving a gross flat yield of £3 12s. 7d.%, or £3 14s. 3d.% allowing for redemption in 1951/5 at 102 or 1955/61 at par—the interest is covered nearly three times. Gas Light 3% perpetual, usually readily available, is obtainable at 81 *xd.* yielding £3 14s.%. Of the recent new issue of 3½% stock by the North Cheshire Gas Company, £57,800 is on offer at 100. The stock is redeemable at par in 1953 and interest accrues from Nov. 10. Tottenham 4%, of which £500 is on offer at par, gives a higher yield than some and interest is covered nearly five times.

Official Quotations on the London Stock Exchange

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Dec. 2.	Rise or Fall on Week.
1,767,439	Sept. 5	8	8	Alliance & Dublin Ord. ...	130—140	...
374,000	June 20	4	4	Do. 4 p.c. Deb. ...	95—100	...
734,733	Nov. 7	5	5	Asscd. Gas & Water U'd'ts Ord.	17/—19/-	...
500,000	,,	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	19/—21/-	...
444,389	,,	4	4	Do. 4 p.c. Red. Cum. Pref.	19/—21/-	...
296,523	,,	4	4	Do. 4 p.c. Irred. Cum. Pref.	16/—18/-	...
500,000	Sept. 5	3½	3½	Do. 3½ p.c. Red. Deb. ...	92—98	...
560 070	Aug. 22	7	7	Barnet Ord. 7 p.c.	157—162	...
300,000	Oct. 10	1/9‡	1/4‡	Bombay, Ltd.	24/—26/-	...
180,435	Aug. 22	9½	9½	Bournemouth sliding scale ...	195—205	...
640,407	,,	7	7	Do. 7 p.c. max. ...	157—162	...
495,960	,,	6	6	Do. 6 p.c. Pref. ...	130—135	...
50,000	June 20	3	3	Do. 3 p.c. Deb. ...	75—80	...
312,025	,,	4	4	Do. 4 p.c. Deb. ...	97—102	...
335,000	,,	5	5	Do. 5 p.c. Deb. ...	115—120	...
357,900	Aug. 8	7½	7½	Brighton, &c., 6 p.c. Con. ...	142—147	...
659,955	,,	6½	6½	Do. 5 p.c. Con. ...	126—131	...
205,500	,,	6	6	Do. 6 p.c. 'B' Pref.	125—130	...
855 000	Sept. 19	8	7	British Ord.	133—138	−2
100,000	June 3	7	7	Do. 7 p.c. Pref.	140—145	...
350,000	,,	5½	5½	Do. 5½ p.c. 'B' Cum. Pref.	110—115	...
120,000	,,	4	4	Do. 4 p.c. Red. Deb. ...	95—100	...
450,000	,,	5	5	Do. 5 p.c. Red. Deb. ...	100—105	...
450,000	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	90—95	...
100,000	22 May'33	6	4	Cape Town, Ltd.	1—2	...
100,000	6 Nov.'33	4½	4½	Do. 4½ p.c. Pref. ...	1½—3½	...
150,000	June 20	4½	4½	Do. 4½ p.c. Deb. ...	60—70	...
626,860	July 18	6	6	Cardiff Con. Ord.	118—123	...
237 860	June 3	5	5	Do. 5 p.c. Red. Deb.	105—110	...
98,936	Sept. 19	2/-	2/-	Colombo Ord....	1½—1¾	...
24,510	,,	1/4†	1/4†	Do. 7 p.c. Pref.... ...	22/6—24/6	...
739,453	Oct. 10	-/11·48	-/11·48	Colonial Gas Assn. Ltd. Ord.	16/6—18/6	...
296,144	,,	1/3·30	1/3·30	Do. 8 p.c. Pref. ...	22/6—24/6	...
1,775 005	Aug. 8	5	5	Commercial Ord.	78—83	...
140,000	,,	—	§13/4	Do. 4 p.c. Red. Pref.	95—100	...
620,000	June 3	3	3	Do. 3 p.c. Deb. ...	72—77	...
286,344	Aug. 22	5	5	Do. 5 p.c. Deb. ...	113—118	...
200,000	,,	—	§30/2	Do. 3½ p.c. Red. Deb.	97—102	...
807,560	Aug. 8	7	7	Croydon sliding scale ...	136—141	...
644,590	,,	5	5	Do. max. div. ...	100—105	...
620 385	June 20	5	5	Do. 5 p.c. Deb. ...	113—118	...
239.000	Aug. 8	5	5	East Hull Ord. 5 p.c.	95—100	...
186,155	Aug. 8	6	6	East Surrey Ord. 5 p.c. ...	116—121	...
176,211	June 3	5	5	Do. 5 p.c. Deb. ...	112—117	...
250.000	Nov. 7	8	4	Gas Consolidation Ord. 'B' ...	19/—21/-	...
250.000	,,	4	4	Do. 4 p.c. Red. Cum. Pref.	17/6—19/6	...
9,223,324	Aug. 8	5⅔	5⅔	Gas Light & Coke Crd. ...	22 3—23/3a	+−/3
2,600,000	,,	3¾	3¾	Do. 3¾ p.c. max. ...	79—82	...
4,477,106	,,	4	4	Do. 4 p.c. Con. Pref....	98—101	...
2,993,000	July 4	—	3½	Do. 3½ p.c. Red. Pref. ...	98—101	...
8 602,497	Nov. 21	3	3	Do. 3 p.c. Con. Deb....	78—81*	...
3,642,770	,,	5	5	Do. 5 p.c. Red. Deb....	109—113*	...
3,500,000	,,	4½	4½	Do. 4½ p.c. Red. Deb....	107—111*	...
700,000	Sept. 5	3½	3½	Do. 3½ p.c. Red. Deb....	93—98	...
270,466	Aug. 22	6	6	Harrogate New Cons. ...	117—122	...
157,500	Mar. 21	1/2⅝	‡1/-	Hong Kong and China Ord. ...	£—1	...
213,200	Aug. 8	6	5⅝	Hornsey Con. 3½ p.c ...	97—102	...
5,600,000	Oct. 24	12	8	Imperial Continental Cap ...	107—112	...
223,130	July 18	3¾	3¾	Do. 3¾ p.c. Red. Deb. ...	87—92	...
235,242	Aug. 8	8¼	8¼	Lea Bridge 5 p.c. Ord. ...	162—167	...
63,480	June 20	3	3	Maidstone 3 p.c. Deb. ...	70—75	...
45,000	Nov. 21	†10	†10	Malta & Mediterranean ...	130—135*	...
				Metropolitan (of Melbourne)		
392.000	Oct. 3	5¼	5¼	5¼ p.c Red. Deb.	100—105	...
231,977	Aug. 22	5	5	M.S. Utility 'C' Cons. ...	99—104	...
968,658	,,	4	4	Do. 4 p.c. Cons. Pref.	95—100	...

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Dec. 2.	Rise or Fall on Week.
390,076	June 20	4	4	M.S. Utility 4 p.c. Deb. ...	95—100	...
148,955	,,	5	5	Do. 5 p.c. Deb. ...	113—118	...
125,000	July 1	3½	3½	Do. 3½ p.c. Red. Bds.	95—98	...
675,000	Nov 21	†6	†6	Montevideo, Ltd.	70—75*	...
250,000	Aug. 8	7½	7½	North Middlesex 6 p.c. Con.	14.—147	...
396,160	Aug. 8	5	5	Northampton 5 p.c. max. ...	105—110	...
300,000	Oct. 24	†7	†9	Oriental, Ltd.	145—150	...
468,537	June 3	8	8	Plymouth & Stonehouse 5 p.c.	140—150	...
621.667	Aug. 8	8½	8½	Portsmouth & Gosport Cons.	157—162	...
241,446	,,	5	5	Do. 5 p.c. max. ...	100—105	...
73.350	,,	5	5	Do. 5 p.c. Pref. ...	107—112	...
75,000	,,	4	4	Do. 4 p.c. Pref. ...	90—95	...
114.000	Aug. 8	5	5	Preston 5 p.c. Pref.	105—110	...
247,966	June 3	4	4	Primitiva 4 p.c. Cons. Deb. ..	98—103	...
625,959	July 18	4	4	Do. 4 p.c. Red. Deb. ...	94—99	...
15,000	Sept. 5	6	6	San Paulo 6 p.c. Cum. Pref. ...	8½—9	...
441,275	Sept. 19	1/1½	1/1½	Severn Val. Gas Cor. Ld. Ord.	20/6—22/6	...
460,810	Sept. 19	-/10⅝	-/10⅝	,, ,, 4½ p.c. Cum. Pref.	19/6—21/6	...
133,201	Aug. 22	5	8½	Shrewsbury 5 p.c. Ord. ...	143—148	...
9,000	June 3	4	†4	South African Ord.	4½—5½	...
1,371,752	Aug. 22	1/2⅝	1/2⅝	South East'n Gas Cn. Ld. Ord.	21/—23/-	...
871.636	,,	-/10⅝	-/10⅝	Do. 4½ p.c. Red. Cum. Pref.	19/—21/-	...
498,818	,,	4	4	Do. 4 p.c. Cum. Pref. ...	18/—20/-	...
450,000	Aug. 8	4	4	Do 4 p.c. Deb.	99—102	...
150,000	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	94—97	...
6,709,895	Aug. 8	6	5	South Met. Ord.	103—106	...
1,135,812	,,	6	6	Do. 6 p.c. Irred. Pref. ...	128—133	...
850,000	,,	4	4	Do. 4 p.c. Irred. Pref. ...	95—100	...
1,895,445	June 20	3	3	Do. 3 p.c. Deb.	75—80	...
1,000,000	July 4	5	5	Do. 5 p.c. Red. Deb. ...	107—112	...
600,000	,,	—	§31/-	Do. 3½ p.c. Red. Deb. ...	97—102	...
1,543,795	Aug. 8	6	6	South Suburban Ord. 5 p.c. ...	113—118	...
512,825	,,	5	5	Do. 5 p.c. Pref.... ...	108—113	...
500,000	,,	4	4	Do. 4 p.c. Pref.... ...	95—100	...
250,000	,,	3½	3½	Do. 3½ p.c. Red. Pref. ...	92—97	+2
888,587	June 3	5	5	Do. 5 p.c. Deb.	115—120	+2
250.000	,,	4	4	Do. 4 p.c. Deb.... ...	95—100	...
200.000	Aug. 8	3½	3½	Do. 3½ p.c. Red. Deb. ...	94—99	...
427,859	Sept. 19	8½	9½	S. Western Gas & Water Ord.	16/—18/-	...
160,523	Oct. 10	-/10½	-/10½	Do. 4½ p.c. Red. Cum. Pf.	19/—21/-	...
110,000	June 3	4	4	Do. 4 p.c. Red. Deb. ...	95—100	...
750,541	Aug. 8	5½	5	Southampton Ord. 5 p.c. ...	105—110	...
148.836	June 3	4	4	Do. 4 p.c. Deb.	95—100	...
350,000	Aug. 8	5½	5½	Swansea 5½ p.c. Red. Pref. ...	105—110	...
200 .000	June 3	3½	3½	Do. 3½ p.c. Red. Deb. ...	93—98	...
1,076,490	Aug. 8	6¾	6¾	Tottenham and District Ord.	125—130	...
409,835	,,	5½	5½	Do. 5½ p.c. Pref. ...	116—121	...
62,235	,,	5	5	Do. 5 p.c. Pref. ...	108—113	...
334.615	June 3	4	4	Do. 4 p.c. Deb. ...	95—100	...
85,701	Nov. 21	6	6	Tuscan 6 p.c. Red. Deb. ...	95—100*	...
1,131,550	Aug. 22	6	4	U. Kingdom Gas Cor. Ord. ...	17/6—19/6	...
1,051,280	Nov. 7	4½	4½	Do. 4½ p.c. 1st Cum. Pref.	19/—21/-	...
762,241	,,	4	4	Do. 4 p.c. 1st Red. Cum. Pf	19/—21/-	...
745,263	June 3	4½	4½	Do. 4½ p.c. 2nd Non-Cum.Pf.	15/6—17/6	...
1,066,186	Sept. 5	3½	3½	Do. 3½ p.c. Red. Deb. ...	95—98	...
375,689	Aug. 8	7	7	Uxbridge, &c., 5 p.c.	125—130	...
133,010	,,	5	5	Do. 5 p.c. Pref. ...	108—113	...
1,371,138	Aug. 8	7	7	Wandsworth Consolidated ...	135—140	...
2,525,768	,,	4	4	Do. 4 p.c. Pref. ...	95—100	...
1,343,964	June 3	5	5	Do. 5 p.c. Deb. ...	115—120	+2
383,745	,,	4	4	Do. 4 p.c. Deb. ...	95—100	...
400,000	,,	—	§25/-	Do. 3½ p.c. Red Deb. ...	97—102	...
558,342	Aug.	7	6⅞	Watford and St. Albans Ord.	128—133	...
200,000	,,	5	5	Do. 5 p.c. Pref. ...	107—112	...
200,000	,,	5½	5½	Do. 5½ p.c. Pref. ...	113—118	...
200,000	,,	—	16/8§	Do. 4 p.c. Red. Pref.	95—100	...
200,000	June 3	4	4	Do. 4 p.c. Red. Deb.	96—101	...
200,000	,,	3½	3½	Do. 3½ p.c. Red. Deb.	92—97	...

a.—The quotation is per £1 of stock. * Ex. div. † Paid free of income-tax. ‡ For year. § Actual.

Supplementary List and Provincial Exchanges overleaf.

STOCK AND SHARE LIST—Cont.

Supplementary List, not Officially Quoted, London

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Nominal Quotations Dec. 2.	Rise or Fall on Week.
202,152	Sept. 5	5	5	Ascot Ord.	101—106	...
128,182	July 18	5	5	Do. 5 p.c. Pref.	108—113	...
31,035	Aug. 22	-/4½	-/4½	Associated Utilities 4 p.c. Pref.	16/-—18/-	...
100,000	Dec. 13	...	3½	Do. 3½ p.c. Red. Deb. ...	95—100	...
17,000	Aug. 22	8	8	Bognor Orig. Ord. 'A' ...	155—165	...
62,210	,,	8	8	Do. New Addl. 'A' ...	155—165	...
87,160	,,	7	7	Do. New 7 p.c. max. ...	145—155	...
37,440	Aug. 8	10	10	Cam. Univ. & Town 10 p.c. max.	155—158	...
125,970	,,	7	7	Do. 7 p.c. max.	133—138	...
39,025	,,	5	5	Do. 5 p.c. max.	97—102	...
96,410	July 18	4½	4½	Cardiff 4½ p.c. Pref.	95—100	...
150,000	Aug. 8	4	4	Croydon 4 p.c. Pref.	97—100	...
130,000	June 20	4	4	Do. 4 p.c. Deb.	95—100	...
65,000	Aug. 8	8½	7½	Eastbourne 'A' 5 p.c. ..	140—145	...
198,000	,,	7	6	Do. 'B' 3½ p.c.	114—119	...
112,312	,,	5	5	Do. 5 p.c. Pref.	107—112	...
130,000	June 20	5	5	Do. 5 p.c. Deb.	112—117	...
24,000	Aug. 8	8½	8½	Great Yarmouth 8½ p.c. max.	43—48	...
59,400	,,	7½	7½	Do. 7½ p.c. max.	33—38	...
51,160	June 3	5½	5½	Do. 5½ p.c. Deb.	121—126	...
152,600	Sept. 5	9	8	Guildford Cons.	163—168	...
54,055	,,	5	5	Do. 5 p.c. Pref.	107—112	...
68,250	June 3	5	5	Do. 5 p.c. Deb	107—112	...
156,600	Aug. 22	7½	7½	Hampton Court Cons. ...	131—136	...
80 000	Aug. 8	4	4	Lea Bridge 4 p.c. Pref. ...	90—95	...
60,000	,,	6	6	Do. 6 p.c. Pref.	121—126	...
94,876	June 3	4	4	Do. 4 p.c. Deb	95—100	...
73,620	Sept. 5	8½	8½	Luton Cons. 'A'	153—163	...
107,960	Sept. 19	5½	4	Mid Kent Ord.	8½—9½	...
230,940	Aug. 8	10	10	Oxford & District Ord. ...	195—200	...
47,112	,,	5	5	Do. 5 p.c. Pref.	106—111	...
50,000	,,	6	6	Do. 6 p.c. Red. Pref. ...	107—112	...
126,193	Nov. 7	7½	7½	Peterborough Ord.	137—142	...
64,990	Sept. 5	6½	7½	Redditch Ord....	118—128	...
166,850	Aug. 8	8	8	Romford Ord....	142—147	...
60,000	,,	4	4	Do. 4 p.c. Pref.	99—103	..
44,000	Sept. 19	5	5	Do. 5 p.c. Deb.	112—117	...
25,570	Aug. 8	5½	5½	Rugby 5½ p.c. Pref.	120—125	...
25,000	,,	6	6	Do. 6 p.c. Red. Pref ...	104—109	...
42,750	June 3	5½	5½	Do. 5½ p.c. Deb.	118—123	...
110,950	Aug. 22	8	8	Ryde Ord.	140—150	...
270,086	Sept 5	7	7	Slough Ord.	128—133	...
21,000	June 20	5	5	Do. 5 p.c. Deb.	110—115	...
28,872	Nov. 7	5½	5½	S. Midland Gas Cpn. Ltd Ord.	19/—21/-*	...
28.866	Sept. 5	4½	4½	Do. 4½ p c Red. Cum. Pref.	18/-—20/-	...
117,228	Aug. 8	7	5	Swindon Cons.	102—107	...
60,425	June 3	5	5	Do. 5 p.c. Deb.	112—117	...
64,380	June 3	5	5	Torquay & Paignton 5 p.c. Pref.	107—112	...
130,000	Aug. 8	8	5	Wakefield Ord.	116—121	...
81,650	,,	5	5	Do. 5 p.c. max.	100—105	...
82,000	Aug. 8	6	6	Weymouth Ord.	103—108	...
98,384	Aug. 22	6	6	Wolverhampton 6 p.c. Pref.	118—123	...
160,000	June 20	5½	5½	Do. 5½ p.c.Rd.Db.	105—110	...
90,000	June 20	5	5	York 5 p.c. Red. Deb. ...	104—109	...
133,640	July 18	6½	6½	Yorktown (Cam.) 5 p.c. Cons.	118—123	...
120,000	,,	5	5	Do. 5 p.c. Pref.	105—110	...
35,000	June 3	5½	5½	Do. 5½ p.c. Deb.	120—125	...

BRISTOL EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Dec. 2.	Rise or Fall on Week.
347,756	July 18	6	5	Bath Cons.	117—119	...
1,667,250	July 18	5	5	Bristol, 5 p.c. max.	112½—114½	...
120,420	June 3	4	4	Do. 1st 4 p.c. Deb. ...	100—102	...
217,870	,,	4	4	Do. 2nd 4 p.c. Deb. ...	100—102	...
328,790	,,	5	5	Do. 5 p.c. Deb.	119—122	...
274,000	Aug. 8	5	5	Newport (Mon). 5 p.c. max....	97—99	...
13,200	Sept. 19	8½	7	Pontyp'l Gas & W. 10 p.c. 'A'	12½—13½	...
13,600	,,	6	5	Do. 7 p.c. 'B'	11½—12½	...
40,000	,,	6	5	Do. 7 p.c. 'C'	11½—12½	...
140,778	Aug. 8	5	5	Weston-super-Mare Cons. ...	106—108	...
64,338	June 20	4	4	Do. 4 p.c. Deb.	100—102	...
33,340	,,	7½	7½	Do 7½ p.c. Deb.	151—154	...

LIVERPOOL EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Dec. 2.	Rise or Fall on Week.
157,150	Aug. 8	6½	5	Chester 5 p.c. Ord.	109—111	...
92,500	June 20	4	4	Do. 4 p.c. Pref.	95—99	...
36,430	,,	3½	3½	Do. 3½ p.c. Deb.	87—90	...
41,890	,,	4	4	Do. 4 p.c. Red. Deb. ...	97—101	...
2,167,410	Aug. 22	6	6	Liverpool 5 p.c. Ord.... ...	122½—124½	+½
245,500	June 20	5	5	Do. 5 p.c. Red. Pref. ...	100—105	...
306,083	July 18	4	4	Do. 4 p.c. Deb.... ...	100—102	...
106,280	Aug. 8	10	10	Preston 'A' 10 p.c.	198—208	...
188,219	,,	7	7	Do. 'B' 7 p.c.	131—141	...

NEWCASTLE EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Dec. 2.	Rise or Fall on Week.
122,577	Aug. 8	8	8	Blyth 5 p.c. Ord.	161—163	...
732,000	Aug. 22	5	5	Hartlepool G. & W. Co. & New	89½—90½	...
2,061,315	Aug. 8	5½	5	Newcastle & Gateshead Con.	22/9-22/3d	...
682,856	,,	4	4	Do. 4 p.c. Pref. ...	99½—100½	+½
776,706	June 20	3½	3½	Do. 3½ p.c. Deb. ...	89 —90	+½
277,285	Oct. 24	5	5	Do. 5 p.c. Deb. '43 ...	103½—105½	...
332,351	Aug. 22	6	6	Sunderland 6 p.c. max. ...	135—137	+½

NOTTINGHAM EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Dec. 2.	Rise or Fall on Week.
542,270	Aug. 8	9	6	Derby Con.	133—138	...
55,000	June 3	4	4	Do. 4 p.c. Deb.	100—105	...
20,000	June 20	5	5	Long Eaton 5 p.c. Pref. ...	10—12	...
80,000	,,	5	5	Do. 5 p.c. Deb. ...	105—110	...

SHEFFIELD EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Dec. 2.	Rise or Fall on Week.
10,000	Aug. 8	10	10	Great Grimsby 'A' Ord. ...	205—215	...
6,500	,,	10	10	Do. 'B' Ord. ...	205—215	...
79,000	,,	10	10	Do. 'C' Ord. ...	195—205	...
1,806,339	Aug. 22	6½	6½	Sheffield Cons.	140—142	...
95.000	July 4	4	4	Do. 4 p.c. Deb.	101—103	...

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